STANDARD OPERATING PROCEDURE
FOR THE SAMPLING OF FISH IN WADEABLE STREAMS THROUGH THE USE OF ELECTROFISHING

The Office of Environmental Measurement and Evaluation
EPA New England - Region 1
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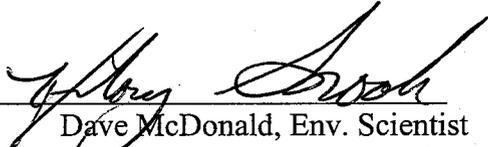
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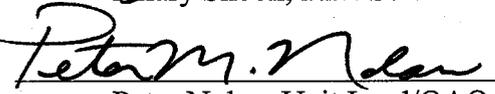
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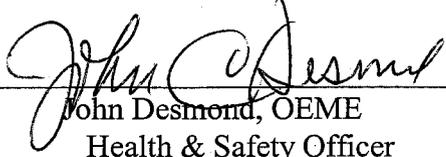
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Revision Page

Date	Rev #	Summary of Changes	Sections
6/20/02	1	Initial Approval	
6/26/02	2	Revised	5.1
7/2/03	N/A	Annual Review Completed - No changes made	N/A
8/14/03	3	Editorial changes	3.4, 7.7.2

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1.0 Scope & Application:

The purpose of this procedure is to provide complete documentation of an appropriate technique for the sampling of fish in wadeable streams through the use of portable electrofishing equipment. The procedure will provide for consistency and efficiency of the sampling effort while maintaining proper safety protocols. This procedure can be used for community surveys, comparative studies and impact assessments.

2.0 Summary of Method:

The method employed calls for the use of electrical power to momentarily stun fish within an effective range from the backpack shocking unit. Based primarily on ambient conductivity and the size and species of fish targeted for collection, a voltage is selected that effectively stuns fish in a non-lethal manner. This allows for the return of fish to the water body unharmed. The minimum sampling team size is three to four individuals. Additional staff can be selected depending on the width of the water body being sampled and the need for complete coverage across the stream. The configuration for a standard sized team consists of one individual wearing a portable shocking unit, two people positioned on either side of the "shocker" and slightly downstream, and a fourth individual behind the netters to transfer netted fish to a temporary holding bin and record data. The sampling is performed moving in an upstream direction focusing on shocking those areas most likely to harbor the targeted fish species.

3.0 Health and Safety Considerations:

The following section outlines health and safety precautions that should be taken while preforming the sampling procedures:

3.1 When working with potentially hazardous materials or situations, follow EPA, OSHA, and specific health or safety procedures.

3.2 All proper personal protection clothing and equipment is to be worn.

3.3 The SOP is to be read by all participants in the sampling effort prior to the survey and a briefing held the day of the survey.

3.4 A backpack shock unit safety and maintenance inspection will be completed annually prior to the beginning of the primary field sampling season, June through October (Attachment D). Any necessary repairs to hardware and safety features

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will be completed prior to any field work. This does not supersede the necessity of pre-survey safety checks.

3.5 A backpack electroshocker safety inspection will be completed prior to each day's use (see Appendix A).

3.6 All waders and gloves should be leak tested daily. Any equipment failing the leak test should be immediately replaced or repaired before use.

3.7 Prior to beginning each day of electrofishing, a team briefing will be held reviewing safety procedures and potential general and site specific hazards.

3.8 Never touch electrodes when the backpack electroshocker is operating.

3.9 At least two members of the electrofishing team should have current CPR certification and Automatic External Defibrillator (AED) training.

3.10 If gloves or boots are encountered leaking, sampling must cease until the equipment is replaced.

3.11 No sampling should take place during heavy rain or snow.

3.12 Individuals with a history of heart problems should not participate in electrofishing activities.

3.13 The power supply should only be connected immediately prior to sampling and disconnected immediately after sampling and before leaving the stream.

3.14 All fuels should be transported in approved gas containers.

4.0 **Equipment and Supplies:**

The following is a list of equipment and supplies necessary to perform electrofishing:

4.0.1 Battery or gas powered portable backpack shocking unit with safety kill switch, anode ring, and rat tail cathode.

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4.0.2 Elbow length rubber lineman's gloves for each team member.

4.0.3 Polarized sunglasses for each team member

4.0.4 Large dip nets

4.0.5 Small dip nets

4.0.6 Holding bucket and/or holding bins

4.0.7 Large holding bin to place all the fish in when taking the data

4.0.8 Measuring tape or line reel for pacing off survey reach (150 meters min.)

4.0.9 Field fish length measuring board

4.0.10 Waterproof data sheets and writing utensils

4.0.11 Portable cellular phone

4.0.12 Chest and hip waders with felt soles

4.0.13 Flagging tape

4.0.14 100 ft of nylon safety line

4.0.15 Inflatable harnesses or safety vests for each team member (if appropriate)

4.0.16 Conductivity meter

4.0.17 Spare parts box for shock units & ancillary equipment

4.0.18 Aerator(s) with battery(s)

4.0.19 Fish key

4.0.20 First aid kit

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4.0.21 Felt sole and wader repair kit

4.0.22 Head nets

4.0.23 Conductivity standards of 0.0001M KCL (14.9 $u$mhos/cm), 0.001M KCL (147 $u$mhos/cm), 0.005M KCL (735 $u$mhos/cm)

4.0.24 18 megohm deionized water

4.0.25 Unleaded gasoline and/or spare charged batteries

4.0.26 TC-W 2 cycle chain saw oil

4.0.27 50:1 mixture of gas to oil for generator fuel (1 qt gasoline:½ oz oil)

5.0 **Personnel Qualifications**

5.1 At least two people on each survey crew must have taken an electrofishing course either from the US Fish and Wildlife Service or similar; and only those individuals will be allowed to wear the backpack unit. All survey crew members must have completed the Office of Environmental Measurement and Evaluation electrofishing training within a year of survey activities. All electrofishing team members are required to read and be familiar with the contents of this SOP.

6.0 **Preparation for Sampling**
The following section outlines the procedures for preparing for a sampling run.

6.1 Determine the conductivity of the water body to be sampled (See G:\ALLSHARE\BIOLOGY\NEWS\SOP's\electro fishing sop.wpd)

6.2 Identify the stream reach to be sampled and mark the beginning of the sampling reach with flagging tape.

6.3 Reference the required sampling (power on) time per reach from the sampling plan and zero the time on the left side of backpack with the magnet.

6.4 Team member sample preparation

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7.4.1 Each member of the team entering the water will wear rubber chest waders with felt soles, elbow length rubber gloves, a pair of polarized sun glasses and a floatation device if warranted.

7.4.2 Individuals netting fish will be equipped with a dip net corresponding to the size of fish expected to be caught and the complexity of habitat to be fished.

7.4.3 The fourth individual walks behind the main crew, netting any missed fish and carrying an aerated seven gallon bucket to hold fish transferred from the primary netters. The water level in the bucket should be at a depth to hold fish in a healthy state. Stressed fish are evidenced by "foam" in the bucket, fish rising to the water surface, or an inability of the fish to remain upright. Special attention and care are needed when dealing with cold water species (i.e. salmon, trout, sculpins).

6.5 Electrofishing backpack unit set-up

6.5.1 After disconnecting electrical connections from the side of the generator, remove the generator or battery from the backpack by releasing the latches on the bottom of the unit or the top velcro straps over the battery.

6.5.2 Fill the tank with the fuel:oil (50:1) mixture. This is enough for 1.7 hours of running time. Wipe any spilled fuel from the outside and then remount the generator on to the backpack unit. If a battery operated shock unit is used, replace the battery with a freshly charged one.

6.5.3 Plug anode (ring/pole) and cathode (rat tail) into their respective connectors on the bottom rear of the instrument case.

6.5.4 Have a team member help place the backpack on the individual who will be electrofishing, and check that all straps, connections, and cables are appropriately attached. Check the backpack's quick release pins if so equipped and ensure they are operable. **All team members should be familiar with doffing the backpack unit in case of emergencies.**

6.5.5 Reconnect the AC and DC electrical connections; if battery operated units are used reconnect the quick disconnect plug into the battery **(Note: The battery is only reconnected immediately before electrofishing operations are to begin).**

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6.5.6   Start the generator by:

a. Turn the fuel cap lever to the on position.

b. Set the output selector on the generator to the 300VA position.

c. Set the engine switch on the generator to the choke position for a cold engine or to the on position for a warm engine.

d. Make certain slack is out of the starter cord and quickly pull.

e. When the engine has started and warmed up move the engine switch from the choke to the "ON" position. If the generator is overloaded (rapid beep and indicator light on) turn it off and restart to reset. The generator output selector should be on 300VA.

f. If using a battery operated unit, connect the quick disconnect plug to the battery and turn the toggle switch on the side of the backpack to "ON."

6.5.7   Select the desired voltage from the voltage range switch located on the right side of the backpack. Effective range for sampling is based on conductivity and any prior sampling experience. In general, 100-400V for water>300 umhos/cm, 700-800V for 100-300umhos/cm and 900-1100V for water <100 umhos/cm.

6.5.8   Select the waveform desired (see P.O.W. reference attached to backpack.)
Note: Use the lowest effective voltage and keep in mind that larger fish are sensitive to (2-3 times) lower voltages. Consequently, low voltages and lower frequencies are most effective for sampling larger fish.

6.5.9   Place the anode ring in the water and depress the reed switch on the anode pole.

6.5.10   Check the overload indicator light. If the light goes on and a rapid beep occurs when the reed switch is engaged reduce the voltage selector until the light no longer turns on. (**Remember** <u>never</u> **to change the voltage while the reed switch is engaged).** If the overload continues with the anode out of water, return to the manufacturer for service.

6.5.11   Check to see that the self test indicator LED is working, the light should be on

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when the reed switch is activated. If the indicator fails to turn on there is a bad connection or internal problem. With the reed switch off, check to see that the anode and cathode connections are properly seated. If after engaging the reed switch again the LED still does not light up, then the backpack shocker is to be returned for service.

6.5.12 Check to make sure that the audio alarm is working when the reed switch is depressed. If the audio alarm does not work return to manufacturer for service.

6.5.13 Tilt the backpack unit greater than 47 degrees. The self test indicator will be flashing and the output will be disabled. Reset by releasing the reed switch on the anode pole. If the indicator does not flash and/or the power is not cut out then the shock unit should be returned for service.

6.5.14 Check to see the response on the fish. Adjust voltage accordingly. **Warning: Never adjust the voltage when the reed switch on the anode pole is activated.**

6.5.15 If the unit overloads, a rapid beep will be heard, the overload indicator light will turn on and the output will be disabled. If the electrofisher is overloaded the unit can be reset by disengaging the reed switch. If the generator is overloaded the unit must be shut down and restarted. In either case a lower voltage selection should be made.

6.5.16 To reset the timer, place a magnet over the word "reset" found next to the timer, or pass the reed switch (which is magnetic) from the anode pole over the word.

6.6 Holding bins and transfer bucket set-up

6.6.1 The holding bins should be placed in-stream and located in an area of slow current and at a depth to allow the net to hang unencumbered. If using a holding tank in lieu a holding bin, place the tank in a shaded section of the stream to help maintain proper water temperature and with sufficient water to keep it from drifting off. An aerator should be placed in the tank and turned on. The aerator should be tested prior to sampling.

6.6.2 Similar to the holding tank, the holding bucket should be filled with stream water at a depth to maintain fish health and minimize stress. An aerator should be placed in the bucket and turned on.

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7.0 Sample Collection

7.1 Fish sampling proceeds in an upstream direction. The backpacker will traverse the stream, shocking habitats likely to contain the target fish species. Notations

are made for the number and species of fish caught in each habitat or as otherwise specified in the Quality Assurance Project Plan (QAPP). Netters proceed at the same pace as the individual shocking and each netter collects stunned fish on their side of the shock unit. Netters should not cross over the anode pole in an effort to collect fish. Netters will also stay inside the radius of the anode pole to remain clear of the voltage source. If an individual begins to fall he or she loudly shouts the word "down," alerting the backpacker to immediately release the reed switch. If a fall has taken place and protective gear has become wet inside, the sampling is temporarily suspended and a replacement person or equipment is put in place or sampling is resumed once the equipment has become dry.

7.2 Individuals netting fish identify the number and type of each fish species caught and make any other necessary observations. Observations or notations are verbally relayed to the individual carrying the bucket and recorded in a standardized field notebook. Standardized abbreviations for New England fish species may be found in Appendix "B."

NOTE: Some surveys may require statistically valid estimates of the resident fish populations. In these cases "pass depletion" or similar methods will be employed in order to accomplish this objective. Details will be described in the QAPP. See Appendix "C" for detailed guidance on the use of these programs and procedures.

7.3 Caught fish will be transferred to the person with the holding bucket. This individual will monitor the health of the fish and make transfers to holding tanks or fish bins if they appear stressed or overcrowded.

7.4 At the completion of the sampling run, total shock time for the reach will be recorded.

7.5 After completing the sampling reach, turn off equipment by switching the generator to the off position and disconnecting the power supply. If a battery unit was used, disengage the quick disconnect from the battery and the unit *before*

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heading back downstream.

7.6   Upon survey completion, fish will be released and returned to the water body with the exception of any unknown species being held for further identification or disposition.

8.0   Data and Records Management:

8.1   Data will be recorded on standardized waterproof data sheets in waterproof field notebooks with waterproof writing utensils.

8.2   While the exact format and type of data collected will vary from project to project, at a minimum the following should be recorded:

8.2.1   Stream name, site name, and sampling date.

8.2.2   Sampling runs and habitat types should be clearly identified as Sampling Run/habitat #1, #2, etc...

8.2.3   Sampled habitats should be identified (i.e. riffle, run, pool), and descriptions of the habitat characteristics made as defined in the QAPP (i.e. depth, type of substrate, shaded, flow velocity, length of habitat).

8.2.4   Standardized abbreviations will be used for fish species logbook notation. A listing of standard fish abbreviations are provided in Appendix "C."

8.2.5   Actual time electro-fished should be recorded in the field log book. Data is recorded from the LED readout on the side of the backpack. The shock unit logs time in seconds and should be recorded as such.

8.2.6   All field log notes should be clear and legible and the name of the person recording data noted. Errors in data recording should be lined out singularly and initialed.

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8.2.7 Voucher specimens may be collected or clear field digital photos taken in lieu for any fish whose species identification is in question.

9.0 **References:** Smith-Root Owners Operation and Maintenance Manual, 1999 (http://www.smith-root.com)

ATTACHMENT A

Electrofishing Principals & Safety

ELECTROFISHING SAFELY
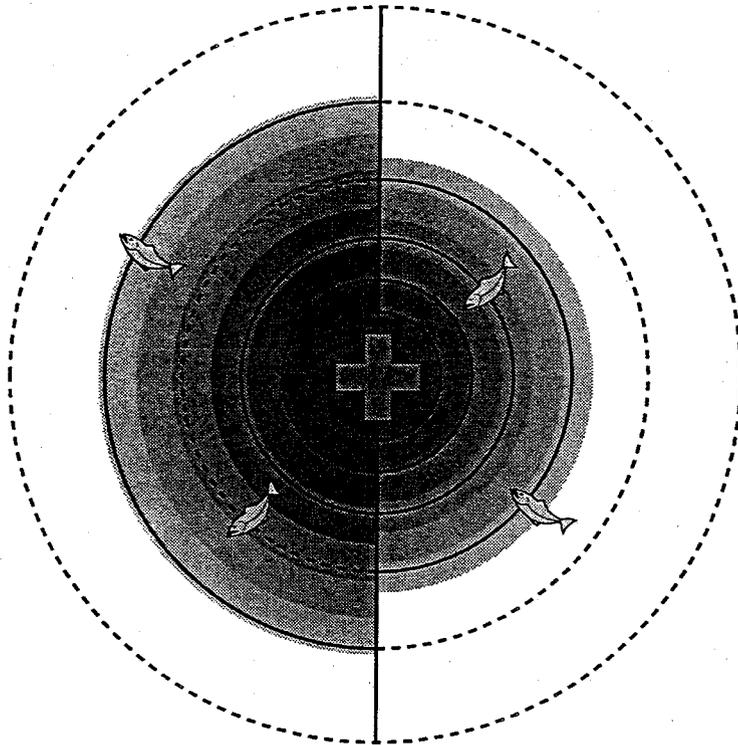
ELECTROFISHING SAFETY

SAFE FISHING

Electrofishing equipment uses voltages and currents that can be lethal to humans. The operators must always keep in mind that the chance of receiving an electrical shock is multiplied in or near water. Using an electrofisher is like using a firearm: if used properly and with good judgment it is perfectly safe; lose respect for it and you can lose your life!

Electrical equipment used in a moist field environment is always subject to deterioration that could lead to dangerous electrical shock. Field equipment is also subjected to vibration and impact during transporting and while in operation. Often equipment shared by different crews does not receive proper maintenance or a complete checkout.

Follow the safety guidelines, and use good common sense to handle unforeseen circumstances.

All personnel involved in electrofishing should be taught the fundamentals of electricity, and have an understanding of the safety requirements.

The most important factor in electrofishing efficiency and safety is the training and experience of the crew. At least two members of the crew should be qualified to administer cardiopulmonary resuscitation. As opportunities arise, all crew members should attend a course in basic life-support training.

ELECTRICAL SHOCK

It is the current that passes through the human body that does the damage. The voltage is relevant, because it is the force that "pushes" the current through the body. Experiments show that 20 to 500 Hz AC current is more dangerous than DC, or higher frequencies of AC.

The voltages used by electrofishing gear cause death by one of three means:

Ventricular Fibrillation

Ventricular fibrillation is uncoordinated contraction of the muscles of the heart. The heart quivers rather than beats. Electrical current through the chest can cause this condition. Once a person goes into ventricular fibrillation, the only way to stop the quivering is to use a defibrillator that applies a pulse shock to the chest to restore heart rhythm. Cardiopulmonary resuscitation may help to keep a victim alive until he can be defibrillated.

Respiratory Arrest

The respiratory center is at the base of the skull. Thus, shocks to the head can cause the breathing to stop. Artificial respiration by the mouth-to-mouth method should be used in this case.

Asphyxia

Asphyxia is caused by contraction of the chest muscles.

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ELECTROFISHING SAFELY

When a current is above a certain level, a person cannot let go of an electrically hot wire. Currents above this level may not cause ventricular fibrillation, but may be enough to cause contraction of the chest muscles. If the current is not stopped, or the victim is not removed from the point of electrical contact, asphyxia will result. Artificial respiration or cardiopulmonary resuscitation may be necessary.

PREVENTING ELECTRICAL SHOCK

Electricity needs to have a complete electrical circuit in order for current to flow. The only way that you can get shocked is if you become the electrical conductor to complete the circuit. The current flows from the cathode to the anode through the water. The water is the electrical conductor. If you touched both the anode and the cathode you would become an electrical conductor and complete the circuit path and get a severe electrical shock. If you were to touch only one of the electrodes, you would not complete the electrical circuit and not get shocked.

WARNING: *Touching any electrode is not recommended. Unless all conductive objects you come into contact with are connected to the same electrode, you will be shocked to find a current path that is not obvious, e.g., the water, or the boat.*

Preventing electrical shock means preventing electrical current from entering and flowing through parts of the body. The skin is a partial but variable barrier, because it offers resistance to the passage of electrical current. Tough skin has more resistance than tender skin, and dry skin more then wet skin. But tough dry skin

alone does not offer enough protection for electrofishing. Rubber lineman's gloves, rated 5,000V minimum should always be worn.

Even while wearing rubber gloves and waders, never touch an electrode while the circuit is energized.

Do not work on the electrical system while the generator is running. Do not enter the water while the current is on during boom shocking operations.

A severe electrical shock from electrofishing gear may result in the need for artificial respiration; therefore it is imperative that no one ever works alone.

To prevent electrical shock all electrical equipment should be carefully inspected before each field operation. With all electrical equipment in good operating condition, and all insulation, junction boxes, bonding, and connections intact, there is much less danger of receiving an electrical shock.

PLANNING FOR SAFETY

1. Never electrofish alone! A minimum of two properly trained people are required for every electrofishing crew.

2. A crew leader shall be appointed for all electrofishing. The crew leader is responsible for the safety of the crew, and the enforcement of all safety regulations.

3. The crew leader, and at least one additional crew member, shall receive training in cardiopulmonary resuscitation (CPR), and First Aid.

4. All electrofishing personnel shall receive training in fundamentals of electricity and safety.

5. Check your electrofisher before each operation, to ensure that it is in good working order.

6. Turn off your electrofisher before making any connections or part replacements.

7. When not in use, and when transporting the unit, disconnect the power supply.

8. Check that the electrofisher gives an audible signal when there is voltage present at the anode.

9. Do not make any field modifications to your electrofisher without written approval from the manufacturer or a qualified electrical engineer.

10. Use only dip nets with insulated handles.

11. Wear personnel flotation devices.

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ELECTROFISHING SAFELY
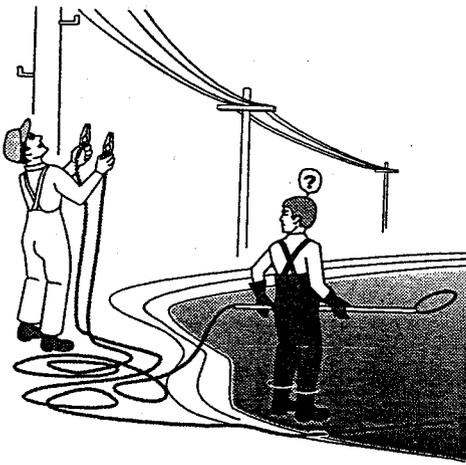
12. Wear lineman's gloves, rated 5,000V minimum.
13. Never reach into the water in vicinity of an electrode, even if rubber gloves are being worn.
14. Take frequent breaks. Stress and fatigue endanger the crew.
15. Practice the quick release system as shown on page C-6.

BACKPACK SAFETY

1. Before each operation, check that the frame emergency release is in working order and check that the tilt switch shuts off power if the unit is tipped more than 45°
2. Wear hip boots or chest-high waders, with non-skid soles.
3. Wear polarized sunglasses to help you detect sub-surface hazards and obstacles. Beware of turbid water that can hide unseen sub-surface obstacles and sudden drop-offs.
4. Shut off your electrofisher before entering or leaving a stream.
5. Do not operate an anode pole when carrying a backpack unit weighing more than 20 pounds when in hazardous conditions.
6. If you get water in boots, waders, or gloves, stop work immediately and get dry clothing
7. Operate slowly and carefully. Footing in most streams is poor, and most falls often occur when operators are hurrying.

BOAT SAFETY

1. Ground the generator to the boat hull.
2. Be sure that all the metal parts on the boat are bonded to each other electrically.
3. Run all cables through electrical conduit, or use a heavy-duty rubber-covered cord recommended for wet locations.
4. Make all electrical connections in water-tight junction boxes.
5. Each dip netter should have his own foot switch to control the output. The switch should be wired in series with the emergency off switch of the boat operator.

6. When wading with a boat, even in shallow water, chest waders should be worn. An operator may trip, end up in a kneeling or sitting position in the water and receive a shock.
7. All crew members must be alert Operators who control the power switch must be constantly aware of the netters in the electrical field.

DO'S AND DON'TS

Do's:

1. Always be sure that all personnel are clear of the electrodes before turning on the power.
2. Know how to administer first aid treatment for electrical shock.
3. Wear flotation devices.
4. Have electrical circuits checked only by qualified technicians.
5. Disconnect the power supply when the electrofisher is not in use.

Don'ts:

1. Don't electrofish alone!
2. Don't continue to electrofish if your boots or gloves get wet inside.
3. Don't operate an electrofisher if you have had any prior heart ailments.
4. Don't operate generators without covers or screens.
5. Don't operate generators without a spark arrester.

ATTACHMENT B

Standard Abbreviations for New England Fish Species

Abbreviation	Common Name	Scientific Name	Tropic	Tolerance
BB	Blueback Herring	*Alosa aestivalis*	F	M
AW	Alewife	*Alosa pseudoharengus*	F	M
AS	American Shad	*Alosa sapidissima*	V	M
RB	Rock Bass	*Ambloplites rupestris*	P	M
YBH	Yellow Bullhead	*Ameiurus natalis*	I	T
BBH	Brown Bullhead	*Ameiurus nebulosus*	I	T
AE	American Eel	*Anguilla rostrata*	P	M
FSS	Fourspine Stickleback	*Apeltes quadracus*	I	M
LNS	Long Nose Sucker	*Catostomus catostmus*	I	M
CWS	Commom White Sucker	*Catostomus commersoni*	O	T
CCS	Creek Chubsucker	*Erimyzon oblongus*	I	M
LW	Lake Whitefish	*Coregonus clupeaformis*	V	M
SCL	Sculpin	*Cottidae*		
SS	Slimy Sculpin	*Cottus cognatus*	I	M
CP	Carp	*Cyprinus carpio*	O	T
RBS	Red Breasted Sunfish	*Lepomis auritus*	I	M
BDS	Banded Sunfish	*Enneacanthus obesus*	I	M
ECP	Eastern Chain Pickerel	*Esox niger*	P	M
RFP	Red Fin Pickerel	*Esox americanus americanus*	P	M
NP	Northern Pike	*Esox lucius*	P	M
SD	Swamp Darter	*Etheostoma fusiforme*	I	M
TD	Tessellated Darter	*Etheostoma olmstedi*	I	I
BDK	Banded Killifish	*Fundulus diaphanus*	I	T
MMG	Mummichog	*Fundulus heteroclitus*	G	M
SB	Stickle Back	*Gasterosteidae*		
TSS	Threespine Stickleback	*Gasterosteus aculeatus*	I	M
SM	Eastern Silvery Minnow	*Hybognathus regius*	H	M
ABL	American Brook Lamprey	*Lampetra appendix*	F	M
CFS	Pumpkinseed	*Lepomis gibbosus*	P	M
BG	Blue Gill	*Lepomis macrochirus*	I	M
BRB	Burbot	*Lota lota*	P	M
SMB	Small Mouth Bass	*Micropterus dolomieu*	P	M
LMB	Large Mouth Bass	*Micropterus salmoides*	P	M
WP	White Perch	*Morone americana*	P	M
CS	Common Shiner	*Luxilus cornutus*	I	M
GS	Golden Shiner	*Notemigonus crysoleucas*	O	T
STS	Spottailed Shiner	*Notropis hudsonius*	I	M
RFS	Roseyface Shiner	*Notropis rubellus*	I	I
BS	Bridle Shiner	*Notropsis bifrenatus*	I	I
BNS	Blacknose Shiner	*Notropsis heterolpis*	I	I
MMT	Margined Madtom	*Noturus insignis*	I	M
COS	Coho Salmon	*Oncorhynchus kisutch*	P	M
RT	Rainbow Trout	*Oncorhynchus mykiss*	P	M
RS	Rainbow Smelt	*Osmerus mordax*	V	M
YP	Yellow Fin Perch	*Perca flavescens*	I	M
YP	Yellow Perch	*Perca flavescens*	I	M
SL	Sea Lamprey	*Petromyzon marinus*	P	M
BC	Black Crappie	*Pomoxis nigromaculatus*	P	M

RW	Round Whitefish	*Prosopium cylindraceum*	I	M
NSS	Ninespine Stickleback	*Pungitius pungitius*	I	M
NRD	Northern Redbelly Dace	*Phoxinus eos*	H	M
FD	Finescale Dace	*Phoxinus neogaeus*	I	M
BND	Black Nose Dace	*Rhinichthys atratulus*	G	T
LND	Long Nose Dace	*Rhinichthys cataractae*	I	I
ATS	Atlantic Salmon	*Salmo salar*	P	M
LLS	Landlocked Salmon	*Salmo salar*	P	M
BT	Brown Trout	*Salmo trutta*	P	M
EBT	E. Brook Trout	*Salvelinus fontinalis*	P	M
LT	Lake Trout	*Salvelinus namaycush*	P	M
CC	Creek Chub	*Semotilus atromaculatus*	O	T
FF	Fall Fish	*Semotilus corporalis*	G	M
WLE	Walleye	*Stizostedion vitreum*	P	M
NTR	Notropis			
MIN	Minnow			
SNAPT	Snapping Turtle			

Notes:

Trophic Designations: P = Piscavore, H = Herbivore, O = Omnivore

I = Insectivore, F = Filter Feeder, G = Generalist feeder,

V = Invertivore

Tolerance Designations: I = Intolerant, M = Intermediate, T = Tolerant

ATTACHMENT B

Standard Abbreviations for New England Fish Species

Abbreviation	Common Name	Scientific Name	Tropic	Tolerance
BB	Blueback Herring	*Alosa aestivalis*	F	M
AW	Alewife	*Alosa pseudoharengus*	F	M
AS	American Shad	*Alosa sapidissima*	V	M
RB	Rock Bass	*Ambloplites rupestris*	P	M
YBH	Yellow Bullhead	*Ameiurus natalis*	I	T
BBH	Brown Bullhead	*Ameiurus nebulosus*	I	T
AE	American Eel	*Anguilla rostrata*	P	M
FSS	Fourspine Stickleback	*Apeltes quadracus*	I	M
LNS	Long Nose Sucker	*Catostomus catostmus*	I	M
CWS	Commom White Sucker	*Catostomus commersoni*	O	T
CCS	Creek Chubsucker	*Erimyzon oblongus*	I	M
LW	Lake Whitefish	*Coregonus clupeaformis*	V	M
SCL	Sculpin	*Cottidae*		
SS	Slimy Sculpin	*Cottus cognatus*	I	M
CP	Carp	*Cyprinus carpio*	O	T
RBS	Red Breasted Sunfish	*Lepomis auritus*	I	M
BDS	Banded Sunfish	*Enneacanthus obesus*	I	M
ECP	Eastern Chain Pickerel	*Esox niger*	P	M
RFP	Red Fin Pickerel	*Esox americanus americanus*	P	M
NP	Northern Pike	*Esox lucius*	P	M
SD	Swamp Darter	*Etheostoma fusiforme*	I	M
TD	Tessellated Darter	*Etheostoma olmstedi*	I	I
BDK	Banded Killifish	*Fundulus diaphanus*	I	T
MMG	Mummichog	*Fundulus heteroclitus*	G	M
SB	Stickle Back	*Gasterosteidae*		
TSS	Threespine Stickleback	*Gasterosteus aculeatus*	I	M
SM	Eastern Silvery Minnow	*Hybognathus regius*	H	M
ABL	American Brook Lamprey	*Lampetra appendix*	F	M
CFS	Pumpkinseed	*Lepomis gibbosus*	P	M
BG	Blue Gill	*Lepomis macrochirus*	I	M
BRB	Burbot	*Lota lota*	P	M
SMB	Small Mouth Bass	*Micropterus dolomieu*	P	M
LMB	Large Mouth Bass	*Micropterus salmoides*	P	M
WP	White Perch	*Morone americana*	P	M
CS	Common Shiner	*Luxilus cornutus*	I	M
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STS	Spottailed Shiner	*Notropis hudsonius*	I	M
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BS	Bridle Shiner	*Notropsis bifrenatus*	I	I
BNS	Blacknose Shiner	*Notropsis heterolpis*	I	I
MMT	Margined Madtom	*Noturus insignis*	I	M
COS	Coho Salmon	*Oncorhynchus kisutch*	P	M
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RS	Rainbow Smelt	*Osmerus mordax*	V	M
YP	Yellow Fin Perch	*Perca flavescens*	I	M

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NSS	Ninespine Stickleback	*Pungitius pungitius*	I	M
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Notes:

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V = Invertivore

Tolerance Designations: I = Intolerant, M = Intermediate, T = Tolerant

ATTACHMENT C

User's Guide For Generating Population Statistics
From
Electrofishing Data

'Microcomputer Software System for Generating Population Statistics **From** Electrofishing **Data—** User's Guide for **MicroFish** 3.0

**John S. Van Deventer
William S. Platts**

THE AUTHORS

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WILLIAM S. PLATTS (retired) was a research fishery biologist for the Intermountain Research Station located at the Forestry Sciences Laboratory in Boise, ID. He received a B.S. degree in conservation education from Idaho State University and M.S. and Ph.D. degrees in fisheries from Utah State University. He previously worked as a regional fishery biologist and supervisor in law enforcement with the Idaho Fish and Game Department, as an Idaho zone fishery biologist for the U.S. Forest Service, and as a consultant to the Surface Environment and Mining (SEAM) program. He has been in his present position since 1976.

COPYING INFORMATION

MicroFish 3.0 is available from the American Fisheries Society Computer Users Section. The cost is $6 if you send a disk, $10 if you don't send a disk. Disks sent must be 5¹/4-inch and double-sided, double-density. Disks should be labeled with the sender's name and address and should be protected with cardboard or a disk mailer to prevent shipping damage. Contact:

Anthony Frank, Librarian
USFWS Great Lakes Fishery Lab
1451 Green Road
Ann Arbor, MI 48105
(313) 994-3331

Once you obtain MicroFish, you may distribute the software to other users only under the following conditions:

1. The American Fisheries Society Computer Users Section (or the authors) must be provided the names and addresses of new users so update notices can be distributed.
2. The software must not be modified in any way.
3. A copy of this user's guide must accompany the software.
4. MicroFish must be distributed free of charge.

For questions concerning this application, you may contact the author at the following address:

Forestry Sciences Laboratory
Intermountain Research Station
USDA Forest Service
316 E. Myrtle Street
Boise, ID 83702
(208) 334-l 457

CONTENTS

4. Type: MF-TEST.DAT <enter>   (this is a test data file)
5. *Type: 1*   (send output to current directory)

A results file, MF-TEST.RES, will be created which should be identical to information shown in appendix 3.

EXAMPLE: MicroFish Sample Size Program (2-D)
1. *Type: MF-SS2D <enter>*   (calculations will take some time to complete)
2. Strike any key   (to continue after graph is displayed)
3. *Type: n*   (to exit)

Results should be identical to output shown in appendix 5.

EXAMPLE: MicroFish Sample Size Program (3-D)
1. Type: *MF-SS3D <enter>*   (calculations will take some time to complete)
2. Strike any key   (to display graph)
3. Strike any key   (to continue after graph is displayed)
4. *Type: n*   (to exit)

Results should be identical to output shown in appendix 6.

MICROFISH INTERACTIVE PROGRAM

Data Entry

The **MicroFish Interactive Program** (program MF.EXE) receives data from user input. There are no external files accessed by this program.

Tips for Efficient Program Operation

1. Entering stream and species names are optional. Press *<enter>* to bypass these.
2. After program execution, 2 yes or no (*y* or *n*) questions ask the user if the results are to be printed and if the program is to be exited. Printing and exiting occur <u>only</u> if a Y (or a *y*) are entered. So, pressing any key (or *<enter>) gives* a "no" response to these questions.

MICROFISH STATISTICAL PACKAGE

Program Input

The **MicroFish Statistical Package** (programs MFISH.EXE and MFISH-DB.EXE) requires three sets of data input: (1) a fish file called MF-FISH.DAT containing numeric codes and fish names; (2) a parameter file called MF-PARM.DAT that can be used to enhance program operation, including detection of data errors; and (3) one or more fish capture data files. In the latter case the data files are named by the user. **MFISH.EXE allows** only one fish capture data file; MFISH-DB.EXE can process multiple files simultaneously.

Data files may be created with whichever line editor, text editor, word processor, etc., you have at your disposal. The data files must be saved as DOS text files (ASCII files). Some packages (for example, spreadsheets and word processors) save files under their own format, not as DOS files. In such cases be sure to use the EXPORT or TEXT IN/OUT capabilities to save files in a DOS format. The three re-quired data files are described in detail below.

FISH FILE (MF-FISH.DAT)

This file should be created by the user to contain numeric codes that identify fish species. Each numeric code is followed by a comma and then by the actual fish name. MF-FISH.DAT *currently* looks like this:

1, Salmon: Chinook
2, Trout: Rainbow
3, Trout: Brook
4, Trout: Bull

5, Trout: Cutthroat
        6, Trout: Brown
       10, Sucker
       11, Sculpin
      100, Whitefish
      101, **Dace**

The fish species code must be a whole number from 1 to 1000, inclusive. *The maximum length of the text description of the species code is 16 characters (excess characters are truncated).* If the species code in the fish capture data file fails to contain a corresponding species code in MF-FISH.DAT, an error message will be displayed during execution of the **MicroFish Statistical Package.**

This file need not be modified if the species listed above are those that are encountered by the user. Modify this file as needed to accommodate your specific needs. The user is strongly encouraged to maintain consistency among fish capture data files with regard to the numeric codes used for identifying fish species.

Because the database output option exists (with MFISH-DB.EXE), the naming of fish becomes more important. When combining multiple database files into one large file, it is often useful to sort by fish names in order to group individual species information. If species names are preceded by group names (for example, trout) then fish groups can be sorted together as well.

PARAMETER FILE (MF-PARM.DAT)

Under normal circumstances, this file should remain as is, without user **modification.** The file contains some user-adjustable parameters that may aid program operation or data error detection. File MF-PARM.DAT looks like this:

```
179
Y
N
scm:
5
1   .   5
5000
```

Parameter 1 is the ASCII character for the vertical bar that appears on MFISH.EXE output. A table of ASCII codes exists in the appendix of your BASIC manual. Some printers are not capable of printing ASCII character 179. In such cases change the *179* in line 1 to 73, which refers to an "I".

Parameter 2 is a parameter that controls error checking and validation of fish capture data. If you are 100 percent certain that your data have been entered in the correct format, you may change this parameter to N for somewhat faster program operation.

Parameter 3 controls the ability of MFISH.EXE to display contents of data files as they are read in. This may be useful for detecting data entry errors. The default for this line is an N. Changing line 3 to a Y causes data to be displayed as they are read into the **MicroFish Statistical Package.**

Parameter 4 operates in conjunction with parameter 3. If line 3 is changed to Y, indicating input data should be displayed, then line 4 controls the output destination. The default of *scrn:* in line 4 routes displayed data to the screen. Changing line 4 *to lpt1:* routes the output to the line printer. Changing line 4 **to** *data-in.lst* (or any other valid file name) directs output to a DOS file.

Parameter 5 stops the maximum-likelihood estimator from going into an infinite loop caused by a severely nondescending number of fish captured on subsequent electroflshing passes. The default of 5 stops the population estimate at five times the total catch.

Microcomputer Software System for Generating Population Statistics From Electrofishing Data— User's Guide for MicroFish 3.0

John S. Van Deventer
William S. Platts

INTRODUCTION

MicroFish is a computer software system that processes electrofishing data obtained by the removal method. **MicroFish** consists of programs written in the BASIC language (compiled using Microsoft **QuickBASIC** 3.0) and is functional on all IBM personal computers and compatibles using DOS 2.0 or higher. **MicroFish** was introduced as the Fisheries Population and Statistical Package (FPSP) (Van Deventer and Platts 1985). The software includes:

MicroFish Interactive Program-This program (MF.EXE) calculates maximum-likelihood population estimates based on user input of fish capture data.

MicroFish Statistical Package (Output: Table Format)-This package of subprograms (MFISH.EXE) calculates maximum-likelihood estimates and a series of fisheries statistics including capture probabilities, lengths, weights, and biomass.

MicroFish Statistical Package (Output: Database Format&Performs the same calculations as the preceding package, except that output is in database format instead of table form.

MicroFish Sample Size Program (2-Dimensions)—The two-dimensional graph displayed by this program (MF-SS2D.EXE) indicates the number of electrofishing passes needed to achieve a desired level of precision. Computer graphics capabilities are required.

MicroFish Sample Size Program (3-Dimensions)—The three-dimensional graph displayed by this program (MF-SS3D.EXE) provides a conceptual foundation for the interrelationships among population size, catchability, electrofishing passes, and precision. Computer graphics capabilities are required.

Examples of output for programs **MF.EXE,** MFISH.EXE, MFISH-DB.EXE, MF-SS2D.EXE, and MF-SS3D.EXE are shown in appendixes 1, 2, 3, 5, and 6.

MicroFish System Files—The following files are included on the **MicroFish** diskette:

MF   .EXE-the **MicroFish Interactive Program.**
MFISH   .EXE-the **MicroFish** Statistical **Package** (Output: Table Format).
MFISH-DB .EXE—the **MicroFish Statistical Package (Output: Database Format).**
MF-SYS   .EXE-a file required by **MicroFish** (of no concern to the user).
MF-SYSDB .EXE-a file required by **MicroFish** (of no concern to the user).

MF-SSBD   .EXE-the **MicroFish Sample Size Program (2-Dimensions).**
MF-SS3D   .EXE-the **MicroFish Sample Size Program (3-Dimensions).**
MF-SSBD   .FIL—calculation information (input parameters) for MF-SS2D.EXE.
MF-SS3D   .FIL-calculation information (input parameters) for MF-SS3D.EXE.

MF-TEST .DAT-a sample **file** of fish capture data.
MF-FISH .DAT-a list of fish names and associated numeric codes.
MF-PARM .DAT-a file of parameters that enhance program operation.

BRUN30 .EXE-the compiler **runtime** module (of no concern to the user).

INSTALLING MICROFISH

This section describes how to load **MicroFish** into *your* computer. If you haven't already done so, please make a backup copy of **MicroFish.** To make a backup, put the **MicroFish** diskette in your a: diskette drive and a blank, formatted diskette in the b: drive, then type:

*copy a. *.* b:* OR *diskcopy a: b:.*

Now you are ready to install **MicroFish.**

Installation: Two Disk Drive System

Place the **MicroFish** diskette in one drive and your data diskette in the other. That's all there is to it.

Installation: Hard Disk System

Create a directory for **MicroFish** and copy the **MicroFish** files to it. (The following instructions assume your hard drive is labeled **C:.**)

1. Type: C: (make the C: hard disk drive the current drive.)
2. *Type: cd\|*   (make the root directory the current directory).
3. *Type: md\mf*   (make a directory called MF for **MicroFish**)
4. *Type: cd\mf*   (change the current directory to the MF directory).
5. Put the **MicroFish** diskette into the A: diskette drive.
6. **Type:** *copy a:*.** (copy **MicroFish** files to the C:\MF directory.)

Installation is now complete.

HOW TO RUN MICROFISH PROGRAMS

EXAMPLE: MicroFish Interactive Program
1. *Type: MF <enter>*
2. Strike any key to continue
3. *Type: Salmon River <enter>*
4. *Type: Rainbow Trout <enter>*
5. *Type: 4 <enter>*
6. *Type: 124 <enter> 61 <enter> 35 <enter> 14 <enter>*
7. *Type: 0*

Results should be identical to output shown in appendix 1.

EXAMPLE: MicroFish Statistical Package (Output: Tables)
1. *Type: MFISH <enter>*   (the title page should show after this)
2. At each pause, strike a key   (do this 4 times, 1 for each display screen)
3. *Type: MF-TEST.DAT <enter>* (this is a test data file)
4. Type: *1*   (send output to the screen)
5. Type: 0   (to exit)

Results should be identical to output shown in appendix 2.

EXAMPLE: MicroFish Statistical Package (Output: Database Format)
1. Type: *MFISH-DB <enter>*   (the title page should show after this)
2. At each pause, strike a key   (do this 4 times, 1 for each display screen>
3. *Type: 1*   (run one data set)

Parameter 6 operates in conjunction with parameter 5. If the population estimate calculation is terminated then the population estimate is arbitrarily reset to 1.5 (the default value) times the total catch. Parameter 6 should be less than parameter 5.

To illustrate, assume the total catch equals 100 fish and parameters 5 and 6 are at their default values of 5 and 1.5, respectively. If a nondescending removal pattern of fish had taken place, the population estimate calculation would be terminated at 5 times the **total** catch **(500)** and would be reset to 1.5 times the total catch (150).

Parameter 7 is an estimate of the maximum number of observations (lines of data) in the fish capture data file for the purpose of memory allocation in the **MicroFish** Statistical **Package.** If you have data sets exceeding the default value of 5,000 observations, then a "Subscript out of range" error will result. In this case, simply change parameter 7 to **a** higher number than the actual number of observations encountered.

FISH **CAPTURE** DATA FILE

Fish capture data files are designed to be as simple as possible, patterned after an electrofishing tally sheet. Detailed data instructions are given below. Perhaps the quickest way to learn the data configuration, however, is to look at the sample file provided (see appendix **4).** The example file of fish capture data is called MF-TEST.DAT.

Setting Up Fish Capture Data

First Line of Data-This line (called the header record) should contain study area information necessary to distinguish this data set from others. The information will appear on table form output (from **MFISH.EXE),** but not in database files (created by MFISH-DB.EXE). Three examples are below:

So. Fk. Salmon River, Idaho, **5/12/88**
Rush Creek, CA Fall, 1988
Third study area, test data

After the header record, subsequent lines of data pertain to captured fish. If individual fish are weighed and measured during electrofishing, then each line (record) in the data set corresponds to an individual fish. Generally, five variables (fields) are expected on each line of data. If fish are counted and weighed in groups then two additional fields are required. If no fish are caught on an electrofishing pass then only three fields are required.

Variable 1. The Site Number-This is the number of the site where the fish was captured. It must be an integer from 1 to the maximum number of sites in sequential order (don't skip numbers). That is, if only one study site is being analyzed in the data set, then the number 1 must be present throughout the length of the data file. If three study sites were **electrofished,** then **MicroFish** expects the numbers **1, 2,** and 3 to be present somewhere in the first column of data.

Variable 2. The Electrofishing Pass Number—If four electrofishing passes were made, then this number would be a **1, 2, 3,** or 4, depending on which electrofishing pass the fish was caught.

Variable 3. The Species **Number**—A species number should be entered here to identify the fish captured. Valid species numbers are from 1 to 1,000. Each species number must correspond to a fish name listed in the file MF-FISH.DAT. Note that species numbers in the sample fish capture data file MF-TEST.DAT (appendix 4) are **2, 3,** 10, and 11, corresponding to Rainbow Trout, Brook Trout, etc., from the file of fish names, MF-FISH.DAT. If no fish were caught on the electrofishing pass, enter a 0 for species number and leave the remaining variables blank. (Actually, this last case is required only when the pass is the last in **a** series of removals, such as the third of three passes.)

Variable 4. The Fish Length-If a value exists, millimeters are expected. (Any units can be used for length and weight, but condition factors will be valid only with millimeters for length and grams for weight, the way the program is set up.)

Variable 5. The Fish Weight-If a value exists, grams are expected.

[Variables 6 and 7 are optional. If for some reason each individual fish was not weighed and measured, then the option of group analysis exists. A unique group must be defined for each species encountered on each electrofishing pass. If individual measurements were performed, these variables can be left blank.1

Variable 6. The Total Number of Fish Captured—If this option is used then variables 4 and 5 <u>must</u> contain periods instead of length and weight measurements. Periods signify missing values.

Variable 7. The Total Weight of Fish Captured—If this option is used then variables 4 and 5 <u>must</u> contain periods instead of length and weight measurements. If neither group weights nor individual weights were taken then put a period in the place of variable 7.

Examples of Fish Capture Data

The following examples illustrate the four allowable types of data lines (not counting the header record):

Line 1 ⇒	1	1	3	100	15.1	
Line 2 ⇒	2	2	10	.	.	3	16.8
Line 3 ⇒	3	2	11	.	.	2	.
Line 4 ⇒	3	4	0			

Line *1* identifies a fish captured from study site 1 on the first electrofishing pass. The species number of 3 indicates from file MF-FISH.DAT that a brook trout was captured. The fish was 100 millimeters in length and weighed 15.1 grams.

Line 2 refers to a group of fish captured. Note that variables 4 and 5 contain periods indicating missing values (no individual fish measurements). This group of fish was captured from study site 2 on the second electrofishing pass. Species number of 10 refers to suckers according to file MF-FISH.DAT. Three suckers were captured with a group weight of 16.8 grams.

Line 3 identifies fish captured in study site 3 on the second electrofishing pass. Species number 11 refers to sculpin. Two fish were captured. No group weight was taken.

Line 4 represents a special situation. In study site 3 on electrofishing pass 4 no fish were captured. In such cases a zero should be entered for the species number. No length and weight information should be entered. A species number of zero is the only species number that will not have a corresponding species name in the file of fish names, MF-FISH.DAT. This special record type is only required when no fish are caught in the entire study area on the last of a series of removals (it signals **to MicroFish** how many electrofishing passes were made).

Notes on Fish Capture Data

Note 1. Data Delimiters—All variables need to be separated by at least one blank space (or a comma, or both). Do not put blank lines in the data.

Note **2. Mixing Individual and Group Measurements**—The **MicroFish Statistical Package** is not capable of performing calculations on a data set in which a single species has a mixture of individually weighed fish and fish weighed in groups. Species A may have grouped measurements and Species B may have individual fish measurements in the same data set, but don't mix individuals and groups within the same species.

Note 3. Number of Electrofishing Passes—The **MicroFish Statistical Package** is capable of comparing several study sites within a study area. The

same number of electrofishing passes must be made at each site in a data set. The largest electrofishing pass number in the data is assumed to be the number of passes at each site.

Program Output

OUTPUT: TABLE FORMAT

MFISH.EXE is capable of outputting fisheries population estimates and statistics in tabular form to the screen, to a line printer, or to a data file. (See appendix 2.)

OUTPUT: DATA-BASE FORMAT

MFISH-DB.EXE creates output data files only. Output files can be sent to any disk drive or directory designated by the user. The following file definition describes the output format from program MFISH-DB.EXE:

Field name	Starting column	Ending column	Field length	Data type
Data file Name	1	12	12	Character
Variable Sort Field	14	15	2	Numeric
Species Sort Field	16	17	2	Numeric
Variable Name	19	30	12	Character
Removal Number	32	32	1	Numeric
Species Name	34	49	16	Character
Overall Value	50	59	10	Numeric
Site 1 Value	60	69	10	Numeric
Site 2 Value	70	79	10	Numeric
Site 3 Value	80	89	10	Numeric

There will be a minimum of one site listed in the output. The output will vary in length, depending on the number of sites sampled. Each site adds 10 characters to the output record length. (See appendix 3.)

OUTPUT FILE EXTENSIONS FROM MFISH-DB.EXE

All MFISH-DB.EXE output results are automatically given a ".RES" file name extension. For example, if a file named FISH1988.DAT is used as input then the results file will be labeled FISH1988.RES.

PROCESSING MULTIPLE DATA FILES WITH MFISH-DB.EXE

MFISH-DB.EXE allows one to process several data sets at once or one at a time. If processing several data sets, a file must be created containing a list of data file names. The data in this list will be processed sequentially. For example, assume the file FISHDATA.LST contains a list of the following fish data files that reside in the DAT87 and DAT88 directories on the C: disk drive:

C:\DAT87\F87-IDAH.DAT
C:\DAT87\F87-OREG.DAT
C:\DAT87\F87-WASH.DAT
C:\DAT88\F88-IDAH.DAT
C:\DAT88\F88-OREG.DAT
C:\DAT88\F88-WASH.DAT

When MFISH-DB prompts

1-Run one data set
2-Run more than one data set

press "2". The user is then prompted

Enter the name of the file
containing data file names:

Now type *FISHDATA.LST center>,* or whatever name you've chosen for the file you created with the list of fish data file names. Output for all six files will be generated.

[Hint: To facilitate creation of data file lists use a DOS "piping" command. For example, typing *DIR *.DAT >*   creates a file called **FISHDATA.LST** consisting of all files with a ".DAT" extension. Use an editor to "clean up" nonessential information from this newly created list of data file names.1

Tips for Program Operation

BYPASSING DIPSLAY SCREENS

Display screens in programs MFISH.EXE and MFISH-DB.EXE can be bypassed by pressing the *ESC*ape key at the initial title page.

ACCESSING DISK DRIVES AND

Specification of PATH calls preceding input or output file names allows the user to retrieve or send data to selected disk drives or directories. For example:

> Input data file:
> Output data file: **C:\OUTPUT\RESULTS.88**

In this example the input tile FISH.DAT is read from disk drive A The output file RESULTS.88 is sent to the OUTPUT directory on disk drive C. In the case of database output (from program **MFISH-DB.EXE**) only the output directory should be specified because file name extensions (".RES") are automatically assigned.

Commonly Asked Questions

Q: Does data in the fish capture data file need to be in any order?
A: No, as *long* as the header record *is* the first line in the data.

Q: Can species be subdivided by age-groups?
A: Yes, the species file MF-FISH.DAT can be set up any way the user desires. Simply change the fish file species codes and descriptions to accommodate your needs. Don't forget to change the species codes in the fish capture data file to their new values. It may be preferable to copy the old fish capture data file to a new file. Then, change the species codes in the new file.

Example: Suppose you ran the **MicroFish Statistical Package** on a data file that only contained rainbow trout (species code 2 according to the original values). After scanning the data, you realize that clear age-class breaks can be made at 100 and 200 mm. The following three species codes might be added to the MF-FISH.DAT data file:

> 20, "RBT < 100 mm"
> 21, "RBT 100-200 mm"
> 22, "RBT > 200 mm"

Once these new species codes are established in MF-FISH.DAT, the fish capture data should be modified to reflect these changes. Rerun the **Statistical Package** to produce population statistics by age class.

Q: How do I compare the same study area over a period of 4 years?
A: Define each year's data as a particular site. For example, this year's data would be considered site 4, last year's data would be site 3, etc.

Q: I didn't collect lengths or weights. How do I process my data?
A: Lengths and weights are not required. In such cases, use the format of example Line 3 where individual length and weight and group weight have missing values. A group total of 1 is permissible.

Q: How can I summarize my fisheries data by date, location, or species?
A: Combine all the necessary database files (output from **MFISH-DB.EXE**) into one large file. If data file names (which are included on each line of output) have been consistently set up to include year and study area, then one can sort on the appropriate fields to organize data by year, location, and species. An example data

file naming convention is **F88-AREA.DAT** where F refers to fisheries data (as opposed to H for habitat, **S** for sediment, etc.), 88 refers to the year, and AREA is a four character designation for the sampling location.

MICROFISH SAMPLE SIZE PROGRAMS

Purpose

The sample size software (programs **MF-SS2D.EXE** and **MF-SS3D.EXE**) answers the question of how many electrofishing passes are required to yield desired levels of precision in the maximum-likelihood population estimate. It is assumed that **electrofishing** is performed using removal-depletion sampling.

A more complete paper, which discusses the interrelationships among population size (*N*), catchability (*P*), population estimate precision, and the number of **electrofishing** passes (*T*), is currently *in* preparation.

Definitions

Catchability is defined as the proportion of fish captured on a given electrofishing pass (for example, each electrofishing pass captures 50 percent of the fish remaining in the stream).

Precision is described in terms of the coefficient of precision, **CP(N)**, a statistic developed by the authors for ease of use. The value associated with the coefficient of precision indicates that the true population size is within a given percentage of the population estimate. Therefore, if the **coefficient** of precision is 10, then the true population size is within 10 percent of the sample estimate at the 95 percent confidence level. If N = 500 and **CP(500)** = 10 then the 95 percent confidence limits around N would equal 450 and 550, respectively.

Introduction

There are two **MicroFish** programs for assessing and understanding **electrofishing** sample size requirements for population estimation. Computer graphics capabilities are required for both programs.

The first program, **MF-SS2D.EXE**, shows sample size relationships among *N, P, T,* and **CP(N)** in two dimensions (2-D). The graph generated by this program has labeled axes and is suitable for field use.

The second program, **MF-SS3D.EXE**, displays sample size relationships in **three-dimensional** (3-D) format to provide an improved conceptual understanding of the relationships among *N, P, T,* and **CP(N)**. Although no axis labels are provided, the X axis refers to population estimate, the Y axis represents catchability, and the **Z** axis identifies the **coefficient** of precision reached by successive electrofishing passes.

Printing

To print graphs from the computer screen, *one* must type in the word *GRAPHICS* (a DOS command) before running the program, then press the Print-Screen key once the graph is displayed.

Adaptability

The graphics are flexible such that the range of parameters [*N, P, T,* and **CP(N)**] can be adjusted to investigate all possible relationships. Color parameters in the software are also adjustable. To change these parameters simply modify the sample size files, **MF-SS2D.FIL** and **MF-SS3D.FIL**. These files are automatically read by the corresponding sample size program each time a program is run.

Adjustable Parameters: MicroFish Sample Size Graph (2-D)

The following is an example of **MF-SS2D.FIL:**

50	350	50		
30	70	5		
2	6	1		
50	1	10	1	
9	1	3	2	1

Line 1 sets the range of population estimates from 50 to 350 in increments of 50.
Line 2 sets catchability from 30 percent to 70 percent in 5 percent increments.
Line 3 sets the number of electrofishing passes from 2 to 6 in increments of 1 (two passes minimum are required).

Parameter 1 of Line 4 sets the maximum CP(*N*) at 50. Parameter 2 should equal 1 to display CP(*N*) scales, zero to suppress scales. Parameter 3 sets the number of increments to be made on the CP(*N*) scale. In the case shown above, precision levels up to CP(*N*) = 50 will be shown in 10 increments (**0, 5,** 10, ... **50).** Parameter 4 displays precision lines behind display bars if the parameter value is 1. These lines are suppressed if parameter 4 is 0.

On Line 5, parameter 1 sets the background color (text mode) for the axis labels. Parameters 2 through 5 set the colors (graphics mode) for palette, graph background color, border color, and scale line color, respectively. Graphics mode colors range from 0 to 3. Refer to an IBM (or compatible) Basic manual.

Adjustable Parameters: MicroFish Sample Size Graph (3-D)

The following is an example of **MF-SS3D.FIL**:

50	*300*	*50*
25	*75*	*5*
2	*6*	*1*
50		
9	*0*	*3*

The **MF-SS3D.FIL** is exactly analogous, except that fewer adjustable parameters are present in line 4. Line 5 lists background color, palette, and line color.

Assessing Sampling Requirements

To estimate electrofishing sample size it is necessary to make rough predictions of N and *P* and to choose a desired precision level. The likelihood of meeting **precision** goals during actual sampling will be increased if the estimates for N and *P* are conservative (lower than the true values).

If one species of the sampled population is of particular interest, the values of N and *P* for that individual species should be used when determining the number of electrofishing passes needed.

Sample size graphs are displayed with several groups of columns, one group for each population estimate. Each group of columns represents the *range* of catchabilities specified by the user. Find the most appropriate values of N and *P* on the graph, then proceed vertically up the column until you reach the desired precision level listed on the left-hand axis. The color of the bar at that point indicates the number of electrofishing passes required to reach that precision level given the values of N and *P.* This is the number of electrofishing passes that should be made in the field.

MICROFISH VERSION 3.0 ENHANCEMENTS

1. The **MicroFish Statistical Package (Database Format),** MFISH-DB.EXE, enables **MicroFish** output to be readily used by other commercial packages. In effect, the output from MFISH-DB.EXE can be imported directly into graphics packages, database managers, spreadsheets, etc.

2. MFISH-DB.EXE permits multiple data file processing.

3. Biomass calculations are performed. Relative percentages of biomass are calculated by species and site.

4. The database format facilitates output file management, file integration, and file coordination.

MICROFISH TECHNICAL NOTES

MicroFish programs perform maximum-likelihood population estimates based on the number of fish captured on each **electrofishing** pass (Van Deventer and Platts 1983). Under certain circumstances **a** maximum-likelihood calculation is not possible (see the Error Handling section).

Values of the Student's *t* distribution used in confidence intervals are taken to 3 decimal places for 100 and fewer degrees of freedom; 2 decimal places for less than 100 degrees of freedom. When the population estimate lower confidence interval is less than the total catch, the lower CI is set equal to the total catch. In this case the **MicroFish Interactive Program** will issue a message. The **MicroFish Statistical Package** will not.

The DOS operating system provides three key sequences that are useful with any program:

Cntl-NumLock—These two keys pressed simultaneously halt the "scrolling" of information on the screen. Pressing any key resumes the scrolling.

Cntl-Break—Terminates program execution at any time.

Alt-Cntl-Del—Terminates all operations and reboots the computer.

ERROR HANDLING

Population Estimate Errors

Maximum-likelihood estimation is not possible in four situations:
1. if a total of 1 fish is caught on all passes,
2. if all fish are caught on the first pass,
3. if there is a severely nondescending removal pattern, or
4. if no fish were caught in the sampling site.

The **MicroFish Statistical Package (Database Format)** will list error numbers in the output file. **The MicroFish Statistical Package (Table Format)** will display the following error messages on the screen when a maximum-likelihood population estimate cannot be calculated:

1 No maximum likelihood estimate generated. Reason: only 1 fish caught in all removals.

2 No maximum likelihood estimate generated. Reason: all fish caught on first pass.

3 Maximum likelihood estimate terminated at 5 times the total catch. Estimate has been arbitrarily reset to 1.5 times the total catch according to MF-PARM.DAT. Population estimate termination was caused by a nondescending removal pattern. Results should not be considered reliable.

4 No maximum likelihood estimate generated. Reason: no fish captured.

In the first, second, and fourth cases the population estimate is set equal to the total catch. Statistics associated with capture probability are set to zero. How **MicroFish** handles the third case is discussed in the "PARAMETER FILE (MF-PARM.DAT)" section of the user's guide (see parameters 5 and 6).

Two of these situations are illustrated by running the example data, MF-TEST.DAT, where removal patterns are flagged and warning messages are issued.

Out of Memory Errors

An "out of memory" error will occur if your computer doesn't have enough memory for both the program and the data. If you have a RAM disk or any other memory-resident modules, reboot your computer without loading them. If that doesn't work, reduce parameter 7 in the MF-PARM.DAT file from the default value of 5,000 down to the number of data lines your fish capture data actually have and rerun the **MicroFish Statistical Package.**

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Other Errors

Data entry errors and improper data formatting are the two biggest problems encountered by **MicroFish** users. Should you encounter an error, try the diagnostic aids recommended in the "PARAMETER FILE **(MF-PARM.DAT)**" section.
Also, sort a copy of your data and check for **(1)** non-sequential assignment of site numbers (other than **1, 2, 3,** etc.), **(2)** species weights of zero, and **(3)** mixture of individual and grouped measurements within **a** single species. Any of these three conditions will cause the program to terminate.

If all else fails, contact the authors for help.

REFERENCES

Van Deventer, J. S.; Platts, W. S. 1983. Sampling and estimating fish populations from streams. Transactions of the North American Wildlife and Natural Resources Conference. 48: 349-354.

Van Deventer, J. S.; Platts, W. S. 1985. A computer software system for entering, managing, and analyzing fish capture data from streams. Res. Note INT-352. Ogden, UT: U.S. Department of Agriculture, Forest Service, Inter-mountain Research Station. 12 p.

APPENDIX 1: OUTPUT EXAMPLE FROM THE MICROFISH INTER-ACTIVE PROGRAM (MF. EXE)

```
stream:   South Fork Salmon River
species:  Rainbow Trout

Removal Pattern:    124  61  35  14
Total Catch               =    234
Population Estimate  =    249

Chi Square                =      0.675
Pop Est Standard Err =      6.164
Lower Conf Interval  =    236.858
Upper Conf Interval  =    261.142

Capture Probability       =      0.501
Capt Prob Standard Err =      0.035
Lower Conf Interval       =      0.432
upper Conf Interval       =      0.570
```

APPENDIX 2: OUTPUT EXAMPLE FROM THE MICROFISH STATISTICAL PACKAGE (MFISH.EXE)

```
FISH   S-G   RESULTS

TITLE:  MICROFISH TEST DATA              Number of Sites  = 3
FILE:   mf-te.st.dat                     Number of Removals= 4
DATE:   09-07-88    1:28 p.m.            Number of Species  = 4
```

REMOVAL PATTERNS

	SPECIES	SITE	RMVL 1	RMVL 2	RMVL 3	RMVL 4
	Trout: Rainbow	1	11	5	3	2
	Trout: Rainbow	2	6	5	2	1
	Trout: Rainbow	3	13	7	5	2
	Trout: Brook	1	22	7	6	3
	Trout: Brook	2	18	11	6	3
	Trout: Brook	3	20	12	4	4
	sucker	1	19	11	6	2
	sucker	2	4	2	0	1
	sucker	3	6	3	3	1
	sculpin	1	12	7	3	0
2	sculpin	2	4	0	0	0
3	sculpin	3	3	2	5	5
	Trout: Rainbow	All Sites	30	17	10	5
	Trout: Brook	All Sites	60	30	16	10
	sucker	Al.1 Sites	29	16	9	4
	sculpin	All Sites	19	9	8	5
	All Species	1	64	30	18	7
	All Species	2	32	18	8	5
	All Species	3	42	24	17	12
	All Species	All Sites	138	72	43	24

WARNING

2 No maximum likelihood estimate generated.
     Reason: all fish caught on 1st pass.

3 Maximum likelihood estimate terminated at 5
     timesthetotal catch. Estimate has been
     arbitrarily reset to 1.5 times the
     total catch according to MF-PARM.DAT.
     Population estimate termination was caused by
     a non-descending removal pattern. Results
     should not be considered reliable.

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FISH CAPTURE TOTALS (% by Species)

SPECIES	SITE = 1		SITE = 2		SITE = 3		TOTAL	
-w-w-	#FISH	%	#FISH	%	#FISH	%	#FISH	%
Trout: Rainbow	21	33.9%	14	22.6%	27	43.5%	62	100.0%
Trout: Brook	38	32.8%	38	32.8%	40	34.5%	116	100.0%
sucker	38	65.5%	7	12.1%	13	22.4%	58	100.0%
Sculpin	22	53.7%	4	9.8%	15	36.6%	41	100.0%
TOTAL	119	43.0%	63	22.7%	95	34.3%	277	100.0%

FISH CAPTURE TOTALS (% by Site)

SPECIES	SITE = 1		SITE = 2		SITE = 3		TOTAL	
	#FISH	%	#FISH	%	#FISH	%	#FISH	%
Trout: Rainbow	21	17.6%	14	22.2%	27	28.4%	62	22.4%
Trout: Brook	38	31.9%	38	60.3%	40	42.1%	116	41.9%
sucker	38	31.9%	7	11.1%	13	13.7%	58	20.9%
sculpin	22	18.5%	4	6.3%	15	15.8%	41	14.8%
TOTAL	119	100.0%	63	100.0%	95	100.0%	277	100.0%

POPULATION ESTIMATES (% by Species)

SPECIES	SITE = 1		SITE = 2		SITE = 3		TOTAL		
	EST	%	EST	%	EST	%	TOTAL	%	EST
Trout: Rainbow	22	33.8%	14	21.5%	29	44.6%	65	100%	67
Trout: Brook	39	32.0%	41	33.6%	42	34.4%	122	100%	125
Sucker	40	65.6%	7	11.5%	14	23.0%	61	100%	62
sculpin	22	44.9%	4	8.2%	23	46.9%	49	100%	47
SITE ESTIMATES	126	41.2%	67	21.9%	113	36.9%	306	100%	305

APPENDIX 2: (Con.>

POPULATION ESTIMATES (% by Site)

SPECIES	SITE = 1		SITE = 2		SITE = 3		TOTAL	
	EST	%	EST	%	EST	%	EST	%
Trout: Rainbow	22	17.9%	14	21.2%	29	26.9%	67	22.3%
Trout: Brook	39	31.7%	41	62.1%	42	38.9%	125	41.5%
sucker	40	32.5%	7	10.6%	14	13.0%	62	20.6%
sculpin	22	17.9%	4	6.1%	23	21.3%	47	15.6%
ESTIMATE TOTALS	123	100.0%	66	100.0%	108	100.0%	301	100.0%
SITE ESTIMATES	126		67		113		305	

POPULATION ESTIMATE STANDARD ERRORS

SPECIES	SITE = 1	SITE = 2	SITE = 3	TOTAL
Trout: Rainbow	1.844	1.154	2.631	4.071
Trout: Brook	1.873	3.170	2.548	5.132
Sucker	2.385	0.612	2.038	3.439
sculpin	0.802	0.000	0.000	5.417
SITE STD ERROR	4.183	3.381	10.016	9.561

POPULATION ESTIMATE 95% CONFIDENCE INTERVALS

SPECIES	SITE = 1		SITE = 2		SITE = 3		TOTAL	
Trout: Rainbow	21,	26	14,	16	27,	34	62,	75
Trout: Brook	38,	43	38,	47	40,	47	116,	135
sucker	38,	45	7,	8	13,	18	58,	69
sculpin	22,	24	4,	4	0,	0	41,	58
SITE ESTIMATES	119,	134	63,	74	95,	133	286,	324

CAPTURE PROBABILITIES

SPECIES	SITE = 1	SITE = 2	SITE = 3	TOTAL
Trout: Rainbow	0.5000	0.5385	0.4655	0.4627
Trout: Brook	0.5429	0.4634	0.5000	0.4754
Sucker	0.5067	0.5833	0.4483	0.4833
Sculpin	0.6286	0.0000	0.0000	0.3905
SITE TOTAL	0.5085	0.4922	0.3640	0.4475

CAPTURE PROBABILITY STANDARD ERROR

SPECIES	SITE = 1	SITE = 2	SITE = 3	TOTAL
Trout: Rainbow	0.1186	0.1416	0.1081	0.0714
Trout: Brook	0.0844	0.0912	0.0858	0.0514
sucker	0.0872	0.1895	0.1593	0.0722
Sculpin	0.1012	0.0000	0.0000	0.0946
SITE CAPT S.E.	0.0490	0.0686	0.0636	0.0342

CAPTURE PROBABILITY 95% CONFIDENCE INTERVALS

SPECIES	SITE = 1	SITE = 2	SITE = 3	TOTAL
Trout: Rainbow	0.2534, 0.7466	0.2326, 0.8443	0.2442, 0.6869	0.3201, 0.6052
Trout: Brook	0.3721, 0.7136	0.2792, 0.6476	0.3267, 0.6733	0.3737, 0.5771
sucker	0.3303, 0.6830	0.1195, 1.0471	0.1043, 0.7923	0.3390, 0.6277
Sculpin	0.4180, 0.8392	0.0000, 0.0000	0.0000, 0.0000	0.2001, 0.5809
SITE 95% C.I.	10.4115, 0.6056	0.3551, 0.6292	0.2380, 0.4899	0.3802, 0.5148

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SPECIES	SITE = 1	SITE = 2	SITE = 3	TOTAL
Trout: Rainbow	0.3591	1.1960	0.3708	0.1757
Trout: Brcok	1.8203	0.1731	1.2897	0.2947
Sucker	0.4914	2.4504	0.7051	0.1809
Sculpin	2.2600	0.0000	0.0000	0.8322
SITE TOTAL	0.5315	0.2636	0.3971	0.2562

CONDITIONFACTORS

SPECIES	SITE = 1	SITE = 2	SITE = 3	TOTAL
Trout: Rainbow	1.320	1.126	1.346	1.288
Trout: Brook	1.232	1.331	1.197	1.252

AVERAGE LENGTHS

SPECIES	SITE = 1	SITE = 2	SITE = 3	TOTAL
Trout: Rainbow	77.9	86.8	70.4	76.7
Trout: Brcok	87.0	90.3	72.6	83.1

LENGTH STANDARD DEVIATIONS

SPECIES	SITE = 1	SITE = 2	SITE = 3	TOTAL
Trout: Rainbow	31.278	40.971	30.719	33.494
Trout: Brcok	36.610	34.146	33.927	35.459

LENGTH 95% CONFIDENCE INTERVALS

SPECIES	SITE = 1	SITE = 2	SITE = 3	TOTAL
Trout: Rainbow	63.7, 92.1	63.1, 110.4	58.3, 82.6	68.2, 85.2
Trout: Brook	75.0, 99.1	79.1, 101.6	61.8, 83.5	76.6, 89.7

APPENDIX 2: (Con.)

TOTAL WEIGHTS (% by Species)

SPECIES	SITE = 1 WEIGHT	%	SITE = 2 WEIGHT	%	SITE = 3 WEIGHT	%	TOTAL WEIGHT	%
Tit-out:Rainbow	188	33.3%	183	32.5%	193	34.2%	565	100.0%
Trout: Brook	474	35.7%	527	39.7%	326	24.5%	1327	100.0%
sucker	230	66.5%	35	10.2%	81	23.3%	347	100.0%
TOTAL	893	39.9%	746	33.3%	600	26.8%	2238	100.0%

TOTAL WEIGHTS (% by Site)

SPECIES	SITE = 1 WEIGHT	%	SITE = 2 WEIGHT	%	SITE = 3 WEIGHT	%	TOTAL WEIGHT	%
Trout:Rainbow	188	21.1%	183	24.6%	193	32.2%	565	25.2%
Trout: Brook	474	53.1%	527	70.7%	326	54.3%	1327	59.3%
sucker	230	25.8%	35	4.7%	81	13.5%	347	15.5%
TOTAL	893	100.0%	746	100.0%	600	100.0%	2238	100.0%

AVERAGE WEIGHTS

SPECIES	SITE = 1	SITE = 2	SITE = 3	TOTAL
Trout: Rainbow	9.0	13.1	7.2	9.1
Trout: Brook	12.5	13.9	8.1	11.4
Sucker	6.1	5.0	6.2	6.0

WEIGHT STANDARD DEVIATIONS

SPECIES	SITE = 1	SITE = 2	SITE = 3	TOTAL
Trout: Rainbow	9.126	16.036	10.996	11.790
Trout: Brook	13.525	17.416	16.030	15.801

APPENDIX 2: (Con.)

WEIGHT 95% CONFIDENCE INTERVALS

SPECIES	SITE = 1	SITE = 2	SITE = 3	TOTAL
Trout: Rainbow	4.8, 13.1	3.8, 22.4	2.8, 11.5	6.1, 12.1
Trout: Brook	8.0, 16.9	8.1, 19.6	3.0, 13.3	8.5, 14.3

ESTIMATED BIOMASS (% by Spec)

SPECIES	SITE = 1		SITE = 2		SITE = 3		TOTAL	
	BIOMASS	%	BIOMASS	%	BIOMASS	%	BIOMASS	%
Trout: Rainbow	197	33.5%	183	31.2%	208	35.3%	588	100.0%
Trout: Brook	487	34.8%	568	40.7%	342	24.5%	1397	100.0%
sucker	243	66.5%	35	9.6%	87	23.8%	365	100.0%
TOTAL	926	39.4%	787	33.5%	637	27.1%	2350	100.0%

ESTIMATED BIOMASS (% by Site)

SPECIES	SITE = 1		SITE = 2		SITE = 3		TOTAL	
	BIOMASS	%	BIOMASS	%	BIOMASS	%	BIOMASS	%
Trout: Rainbow	197	21.3%	183	23.3%	208	32.6%	588	25.0%
Trout: Brook	487	52.5%	568	72.2%	342	53.7%	1397	59.5%
Sucker	243	26.2%	35	4.5%	87	13.7%	365	15.5%
TOTAL	926	100.0%	787	100.0%	637	100.0%	2350	100.0%

APPENDIX 3: OUTPUT EXAMPLE FROM THE MICROFISH STATISTICAL PACKAGE (MFISH-DB.EXE)

MF-TEST	.DAT	1 0	Fish Removal	1	ALL SPECIES	138	64	32	42
MF-TEST	.DAT	1 0	Fish Removal	2	ALL SPECIES	72	30	18	24
MF-TEST	.DAT	1 0	Fish Removal	3	ALL SPECIES	43	18	8	17
MF-TEST	.DAT	1 0	Fish Removal	4	ALL SPECIES	24	7	5	12
MF-TEST	.DAT	1 1	Fish Removal	1	Trout: Rainbow	30	11	6	13
MF-TEST	.DAT	1 1	Fish Removal	2	Trout: Rainbow	17	5	5	7
MF-TEST	.DAT	1 1	Fish Removal	3	Trout: Rainbow	10	3	2	5
MF-TEST	.DAT	1 1	Fish Removal	4	Trout: Rainbow	5	2	1	2
MF-TEST	.DAT	1 2	Fish Removal	1	Trout: Brook	60	22	18	20
MF-TEST	.DAT	1 2	Fish Removal	2	Trout: Brook	30	7	11	12
MF-TEST	.DAT	1 2	Fish Removal	3	Trout: Brook	16	6	6	4
MF-TEST	.DAT	1 2	Fish Removal	4	Trout: Brook	10	3	3	4
MF-TEST	.DAT	1 3	Fish Removal	1	Sucker	29	19	4	6
MF-TEST	.DAT	1 3	Fish Removal	2	Sucker	16	11	2	3
MF-TEST	.DAT	1 3	Fish Removal	3	Sucker	9	6	0	3
MF-TEST	.DAT	1 3	Fish Removal	4	Sucker	4	2	1	1
MF-TEST	.DAT	1 4	Fish Removal	1	Sculpin	19	12	4	3
MF-TEST	.DAT	1 4	Fish Removal	2	Sculpin	9	7	0	2
MF-TEST	.DAT	1 4	Fish Removal	3	Sculpin	8	3	0	5
MF-TEST	.DAT	1 4	Fish Removal	4	Sculpin	5	0	0	5
MF-TEST	.DAT	2 0	Rmvl Warning		ALL SPECIES	0	0	0	0
MF-TEST	.DAT	2 1	Rmvl Warning		Trout: Rainbow	0	0	0	0
MF-TEST	.DAT	2 2	Rmvl Warning		Trout: Brook	0	0	0	0
MF-TEST	.DAT	2 3	Rmvl Warning		sucker	0	0	0	0
MF-TEST	.DAT	2 4	Rmvl Warning		Sculpin	0	0	2	3
MF-TEST	.DAT	3 0	Fish Totals		ALL SPECIES	277	119	63	95
MF-TEST	.DAT	3 1	Fish Totals		Trout: Rainbow	62	21	14	27
MF-TEST	.DAT	3 2	Fish Totals		Trout: Brook	116	38	38	40
MF-TEST	.DAT	3 3	Fish Totals		sucker	58	38	7	13
MF-TEST	.DAT	3 4	Fish Totals		sculpin	41	22	4	15
MF-TEST	.DAT	4 0	Fish %--Spec		ALL SPECIES	100.0	43.0	22.7	34.3
MF-TEST	.DAT	4 1	Fish %--Spec		Trout: Rainbow	100.0	33.9	22.6	43.5
MF-TEST	.DAT	4 2	Fish %--Spec		Trout: Brook	100.0	32.8	32.8	34.5
MF-TEST	.DAT	4 3	Fish %--Spec		sucker	100.0	65.5	12.1	22.4
MF-TEST	.DAT	4 4	Fish %--Spec		Sculpin	100.0	53.7	9.8	36.6
MF-TEST	.DAT	5 0	Fish %--Site		ALL SPECIES	100.0	100.0	100.0	100.0
MF-TEST	.DAT	5 1	Fish %--Site		Trout: Rainbow	22.4	17.6	22.2	28.4
MF-TEST	.DAT	5 2	Fish%-Site		Trout: Brook	41.9	31.9	60.3	42.1
MF-TEST	.DAT	5 3	Fish%-Site		sucker	20.9	31.9	11.1	13.7
MF-TEST	.DAT	5 4	Fish%-Site		Sculpin	14.8	18.5	6.3	15.8
MF-TEST	.DAT	6 0	Pop Estimate		ALL SPECIES	305	126	67	113
MF-TEST	.DAT	6 1	Pop Estimate		Trout: Rainbow	67	22	14	29
MF-TEST	.DAT	6 2	Pop Estimate		Trout: Brook	125	39	41	42
MF-TEST	.DAT	6 3	Pop Estimate		sucker	62	40	7	14
MF-TEST	.DAT	6 4	Pop Estimate		sculpin	47	22	4	23
MF-TEST	.DAT	7 0	Est %--Spec		ALL SPECIES	100.0	41.2	21.9	36.9
MF-TEST	.DAT	7 1	Est %--Spec		Trout: Rainbow	100.0	33.8	21.5	44.6
MF-TEST	.DAT	7 2	Est %--Spec		Trout: Brook	100.0	32.0	33.6	34.4
MF-TEST	.DAT	7 3	Est %--Spec		sucker	100.0	65.6	11.5	23.0
MF-TEST	.DAT	7 4	Est %--Spec		sculpin	100.0	44.9	8.2	46.9
MF-TEST	.DAT	8 0	Est %--Site		ALL SPECIES	100.0	100.0	100.0	100.0
MF-TEST	.DAT	8 1	Est %--Site		Trout: Rainbow	22.3	17.9	21.2	26.9
MF-TEST	.DAT	8 2	Est %--Site		Trout: Brook	41.5	31.7	62.1	38.9
MF-TEST	.DAT	8 3	Est %--Site		sucker	20.6	32.5	10.6	13.0

MF-TEST	.DAT	8 4	Est %--Site	Sculpin	15.6	17.9	6.1	21.3
MF-TEST	.DAT	9 0	Est Std Err	ALL SPECIES	9.561	4.183	3.381	10.016
MF-TEST	.DAT	9 1	Est Std Err	Trout: Rainbow	4.071	1.844	1.154	2.631
MF-TEST	.DAT	9 2	Est Std Err	Trout: Brook	5.132	1.873	3.170	2.548
MF-TEST	.DAT	9 3	Est Std Err	Sucker	3.439	2.385	0.612	2.038
MF-TEST	.DAT	9 4	Est Std Err	Sculpin	5.417	0.802	0.000	0.000
MF-TEST	.DAT	10 0	Est Lower CI	ALL SPECIES	286	119	63	95
MF-TEST	.DAT	10 1	Est Lower CI	Trout: Rainbow	62	21	14	27
MF-TEST	.DAT	10 2	Est Lower CI	Trout: Brook	116	38	38	40
MF-TEST	.DAT	10 3	Est Lower CI	**sucker**	58	38	7	13
MF-TEST	.DAT	10 4	Est Lower CI	Sculpin	41	22	4	0
MF-TEST	.DAT	11 0	Est Upper CI	ALL SPECIES	324	134	74	133
MF-TEST	.DAT	11 1	Est Upper CI	Trout: Rainbow	75	26	16	34
MF-TEST	.DAT	11 2	Est Upper CI	Trout: Brook	135	43	47	47
MF-TEST	.DAT	11 3	Est Upper CI	sucker	69	45	8	18
MF-TEST	.DAT	11 4	Est Upper CI	Sculpin	58	24	4	0
MF-TEST	.DAT	12 0	Capt Prob	ALL SPECIES	0.447	0.509	0.492	0.364
MF-TEST	.DAT	12 1	Capt Prob	Trout: Rainbow	0.463	0.500	0.538	0.466
MF-TEST	.DAT	12 2	Capt Prob	Trout: Brook	0.475	0.543	0.463	0.500
MF-TEST	.DAT	12 3	Capt Prob	sucker	0.483	0.507	0.583	0.448
MF-TEST	.DAT	12 4	Capt Prob	sculpin	0.390	0.629	0.000	0.000
MF-TEST	.DAT	13 0	Capt Prob SE	ALL SPECIES	0.034	0.049	0.069	0.064
MF-TEST	.DAT	13 1	Capt Prob SE	Trout: Rainbow	0.071	0.119	0.142	0.108
MF-TEST	.DAT	13 2	Capt Prob SE	Trout: Brook	0.051	0.084	0.091	0.086
MF-TEST	.DAT	13 3	Capt Prob SE	sucker	0.072	0.087	0.190	0.159
MF-TEST	.DAT	13 4	Capt Prob SE	sculpin	0.095	0.101	0.000	0.000
MF-TEST	.DAT	14 0	C P Lower CI	ALL SPECIES	0.380	0.412	0.355	0.238
MF-TEST	.DAT	14 1	C P Lower CI	Trout: Rainbow	0.320	0.253	0.233	0.244
MF-TEST	.DAT	14 2	C P Lower CI	Trout: Brook	0.374	0.372	0.279	0.327
MF-TEST	.DAT	14 3	C P Lower CI	sucker	0.339	0.330	0.120	0.104
MF-TEST	.DAT	14 4	C P Lower CI	sculpin	0.200	0.418	0.000	0.000
MF-TEST	.DAT	15 0	C P Upper CI	ALL SPECIES	0.515	0.606	0.629	0.490
MF-TEST	.DAT	15 1	C P Upper CI	Trout: Rainbow	0.605	0.747	0.844	0.687
MF-TEST	.DAT	15 2	C P Upper CI	Trout: Brook	0.577	0.714	0.648	0.673
MF-TEST	.DAT	15 3	C P Upper CI	sucker	0.628	0.683	1.047	0.792
MF-TEST	.DAT	15 4	C P Upper CI	Sculpin	0.581	0.839	0.000	0.000
MF-TEST	.DAT	16 0	Chi Square	ALL SPECIES	0.256	0.532	0.264	0.397
MF-TEST	.DAT	16 1	Chi Square	Trout: Rainbow	0.176	0.359	1.196	0.371
MF-TEST	.DAT	16 2	Chi Square	Trout: Brook	0.295	1.820	0.173	1.290
MF-TEST	.DAT	16 3	Chi Square	sucker	0.181	0.491	2.450	0.705
MF-TEST	.DAT	16 4	Chi Square	sculpin	0.832	2.260	0.000	0.000
MF-TEST	.DAT	17 1	Cond Factor	Trout: Rainbow	1.288	1.320	1.126	1.346
MF-TEST	.DAT	17 2	Cond Factor	Trout: Brook	1.252	1.232	1.331	1.197
MF-TEST	.DAT	18 1	Avg Length	Trout: Rainbow	76.661	77.905	86.786	70.444
MF-TEST	.DAT	18 2	Avg Length	Trout: Brook	83.147	87.026	90.342	72.625
MF-TEST	.DAT	19 1	Len Std Dev	Trout: Rainbow	33.494	31.278	40.971	30.719
MF-TEST	.DAT	19 2	Len Std Dev	Trout: Brook	35.459	36.610	34.146	33.927
MF-TEST	.DAT	20 1	Len Lower CI	Trout: Rainbow	68.154	63.667	63.134	58.290
MF-TEST	.DAT	20 2	Len Lower CI	Trout: Brook	76.628	74.994	79.120	61.773
MF-TEST	.DAT	21 1	Len Upper CI	Trout: Rainbow	85.169	92.142	110.438	82.599
MF-TEST	.DAT	21 2	Len Upper CI	Trout: Brook	89.665	99.059	101.565	83.477
MF-TEST	.DAT	22 0	Total Weight	ALL SPECIES	2238.1	892.8	745.6	599.7
MF-TEST	.DAT	22 1	Total Weight	Trout: Rainbow	564.8	188.0	183.5	193.3
MF-TEST	.DAT	22 2	Total Weight	Trout: Brook	1326.8	474.3	526.9	325.6

MF-TEST .DAT 22 3 Total Weight	sucker	346.5	230.5	35.2	80.8
MF-TEST .DAT 23 0 Wt % -- Spec	ALL SPECIES	100.0	39.9	33.3	26.8
MF-TEST .DAT 23 1 Wt % -- Spec	Trout: Rainbow	100.0	33.3	32.5	34.2
MF-TEST .DAT 23 2 Wt % -- Spec	Trout: Brook	100.0	35.7	39.7	24.5
MF-TEST .DAT 23 3 Wt % -- Spec	sucker	100.0	66.5	10.2	23.3
MF-TEST .DAT 24 0 Wt % -- Site	ALL SPECIES	100.0	100.0	100.0	100.0
MF-TEST .DAT 24 1 Wt % -- Site	Trout: Rainbow	25.2	21.1	24.6	32.2
MF-TEST .DAT 24 2 Wt % --Site	Trout: Brook	59.3	53.1	70.7	54.3
MF-TEST .DAT 24 3 Wt % -- Site	sucker	15.5	25.8	4.7	13.5
MF-TEST .DAT 25 0 Avg Weight	ALL SPECIES	8.1	7.5	11.8	6.3
MF-TEST .DAT 25 1 Avg Weight	Trout: Rainbow	9.1	9.0	13.1	7.2
MF-TEST .DAT 25 2 Avg Weight	Trout: Brook	11.4	12.5	13.9	8.1
MF-TEST .DAT 25 3 Avg Weight	sucker	6.0	6.1	5.0	6.2
MF-TEST .DAT 26 1 Wt Std Dev	Trout: Rainbow	11.790	9.126	16.036	10.996
MF-TEST .DAT 26 2 Wt Std Dev	Trout: Brook	15.801	13.525	17.416	16.030
MF-TEST .DAT 27 1 Wt Lower CI	Trout: Rainbow	6.1	4.8	3.8	2.8
MF-TEST .DAT 27 2 Wt Lower CI	Trout: Brook	8.5	8.0	8.1	3.0
MF-TEST .DAT 28 1 Wt Upper CI	Trout: Rainbow	12.1	13.1	22.4	11.5
MF-TEST .DAT 28 2 Wt Upper CI	Trout: Brook	14.3	16.9	19.6	13.3
MF-TEST .DAT 29 0 Est Biomass	ALL SPECIES	2350.1	926.4	787.2	636.5
MF-TEST .DAT 29 1 Est Biomass	Trout: Rainbow	588.1	197.0	183.5	237.6
MF-TEST .DAT 29 2 E&Biomass	Trout: Brook	1397.2	486.8	568.5	341.9
MF-TEST .DAT 29 3 Est Bicnnass	sucker	364.8	242.6	35.2	87.0
IQ-TEST .DAT 30 0 Est Bio % Sp	ALL SPECIES	100.0	39.4	33.5	27.1
MF-TEST .DAT 30 1 Est Bio % Sp	Trout: Rainbow	100.0	33.5	31.2	35.3
MF-TEST .DAT 30 2 Est Bio % Sp	Trout: Brook	100.0	34.8	40.7	24.5
MF-TEST .DAT 30 3 Est Bio % Sp	sucker	100.0	66.5	9.6	23.8
IQ-TEST .DAT 31 0 Est Bio % Si	ALL SPECIES	100.0	100.0	100.0	100.0
IQ-TEST .DAT 31 1 Est Bio % Si	Trout: Rainbow	25.0	21.3	23.3	32.6
MF-TEST .DAT 312 Est Bio % Si	Trout: Brook	59.5	52.5	72.2	53.7
MF-TEST .DAT 313 Est Bio % Si	sucker	15.5	26.2	4.5	13.7

APPENDIX 4: SAMPLE DATA (MF-TEST.DAT)

```
MICROFISH  TEST  DATA
1    1    3    161    42.5
1    1    2    118    17
1    1    2    104    16.9
1    1    3    119    27
1    1    3    130    30.9
1    1    2     98    17.2
1    1    2    118    22.2
1    1    3    100    15.1
1    1   10      .       .      11      68.2
1    1   11      .       .       7
1    2    3    110    18.2
1    2    3    129    29.2
1    2    2    110    19.4
1    2   10      .       .      11      58.3
1    2   11      .       .       7
1    3    3    102    16.5
1    3    3    119    26.5
1    4    3    130    29.8
1    1    3    164    49.5
1    1    2    133    31.2
1    1    3    114    16
1    1    2     96    10.9
1    1    3     68     3.5
1    1    3     77     6
1    1    3     78     3.5
1    1    2     79     4.6
1    1    3     69     4.1
1    1    3     52     1.6
1    1    3     46     1.2
1    1    2     45     1.5
1    1    3     60     3.4
1    1   10      .       .       8      49.6
1    1   11      .       .       3
1    2    2     57     2.1
1    3    3     95     9.3,
1    4    2    101    10.1
1    4    3     69     3.5
1    1    3    121    19.2
1    1    3    155    36.6
1    1    2    118    18.6
1    1    3     57     3.4
1    1    3    110    15.2
1    1    2     60     4.1
1    1    3     72     6.4
1    1    3     71     5.9
1    1    3     55     4.4
1    1    3     67     2.4
1    1    2     41     2.5
1    1    3     60     1.2
1    1   11      .       .       2
1    2    3    139    30.8
1    2    2     62     2.8
1    2    3     38      .5
```

12		3	68	3.9		
12		2	55	2.3		
12		3	47	1.5		
12		2	39	.5		
12		3	35	.5		
13		3	43	• 7		
13		2	50	.9		
13		3	47	.9		
13		2	43	. 5		
13		3	62	1.6		
13		2	46	1.3		
1	3	10	.	.	6	42.6
1	3	11	•	•	3	.
14		2	63	1.4		
14		3	68	2		
1	4	10	•	•	2	11.8
2		13	190	94.9		
2		13	157	49.4		
2		12	101	12.8		
2		13	118	18.5		
2		13	132	25.4		
2		13	109	16.8		
2		12	71	5.1		
2		13	50	3.1		
2		13	61	5		
2		13	50	3.2		
2	1	10	.	.	4	19.6
2	1	11	.	•	4	.
2	2	3	56	3.7		
2	2	2	52	2.3		
2	2	3	99	11.5		
2	2	3	59	2.8		
2	2	2	37	.5		
2	2	3	66	3.9		
2	2	10	•	.	2	10.8
2	3	3	51	1.5		
2	3	3	44	1.4		
2	3	3	64	3.5		
2	4	2	60	1.7		
2	4	3	62	2.1		
2	4	10	•		1	4.8
2		13	109	15'		
2		12	47	1.1		
2		13	55	1.3		
2	2	3	101	11.1		
2	2	3	55	.9		
2	2	2	50	.5		
2	2	3	65	2.2		
2	2	3	71	4.4		
2	3	2	57	. 8		
2	3	3	72	2.4		
2	3	3	61	4.0		
2	4	3	99	10.8		
2		12	161	42.5		

2	1	3	118	17		
2	1	3	104	16.9		
2	1	2	119	27		
2	1	3	130	30.9		
2	1	3	98	17.2		
2	1	3	118	22.2		
2	1	3	100	15.1		
2	2	2	110	18.2		
2	2	3	129	29.2		
2	2	3	110	19.4		
2	3	2	90	10.6		
2	1	2	164	49.5		
2	1	3	133	31.2		
2	1	3	114	16		
2	2	2	96	10.9		
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2	4	3	78	3.5		
3	1	3	79	4.6		
3	1	2	69	4.1		
3	1	3	52	1.6		
3	1	3	46	1.2		
3	1	3	45	1.5		
3	1	2	60	3.4		
3	1	10	.	.	6	37.2
3	1	11		.	3	
3	2	2	5;	2.1		
3	3	2	95	9.2		
3	4	3	101	10.1		
3	4	3	69	3.5		
3	1	2	121	19.2		
3	1	3	155	36.6		
3	1	3	118	18.6		
3	1	3	57	3.4		
3	1	3	110	15.2		
3	1	2	60	4.1		
3	1	3	72	6.4		
3	1	2	71	5.9		
3	1	3	55	4.4		
3	1	3	67	2.4		
3	1	2	41	2.5		
3	1	3	60	1.2		
3	2	2	139	30.8		
3	2	3	62	2.8		
3	2	3	38	.5		
3	2	3	68	3.9		
3	2	2	55	2.3		
3	2	3	47	1.5		
3	2	3	39	.5		
3	2	3	35	.5		
3	2	10	.	.	3	16.8
3	2	11	.	.	2	
3	3	2	43	.7		
3	3	3	50	.9		

3	3	2	47	.9		
3	3	2	43	.5		
3	3	3	62	1.6		
3	3	3	46	1.3		
3	3	10	.	.	3	21.0
3	3	11	.	.	5	.
3	4	3	63	1.4		
3	4	2	68	2		
3	4	10	.	.	1	5.8
3	4	11	.	.	5	.
3		13	190	94.9		
3		12	157	49.4		
3		13	101	12.8		
3		13	118	18.5		
3	1	3	132	25.4		
3		12	109	16.8		
3		13	71	5.1		
3		12	50	3.1		
3		12	61	5		
3		13	50	3.2		
3		13	56	3.7		
3		12	52	2.3		
3	2	3	99	11.5		
3	2	2	59	2.8		
3	2	3	37	.5		
3	2	3	66	3.9		
3	2	2	51	1.5		
3	3	2	44	1.4		
3	3	3	64	3.5		
3	4	2	60	1.7		
3		12	109	15		
3		13	47	1.1		
3		12	55	1.3		
3	2	3	101	11.1		
3	2	2	55	.9		
3	2	3	50	.5		
3	2	3	65	2.2		
3	2	2	71	4.4		
3	4	3	62	2.1		

ELECTROFISHING SAMPLE SIZE
Catchability (%) from 30 to 70 by 5
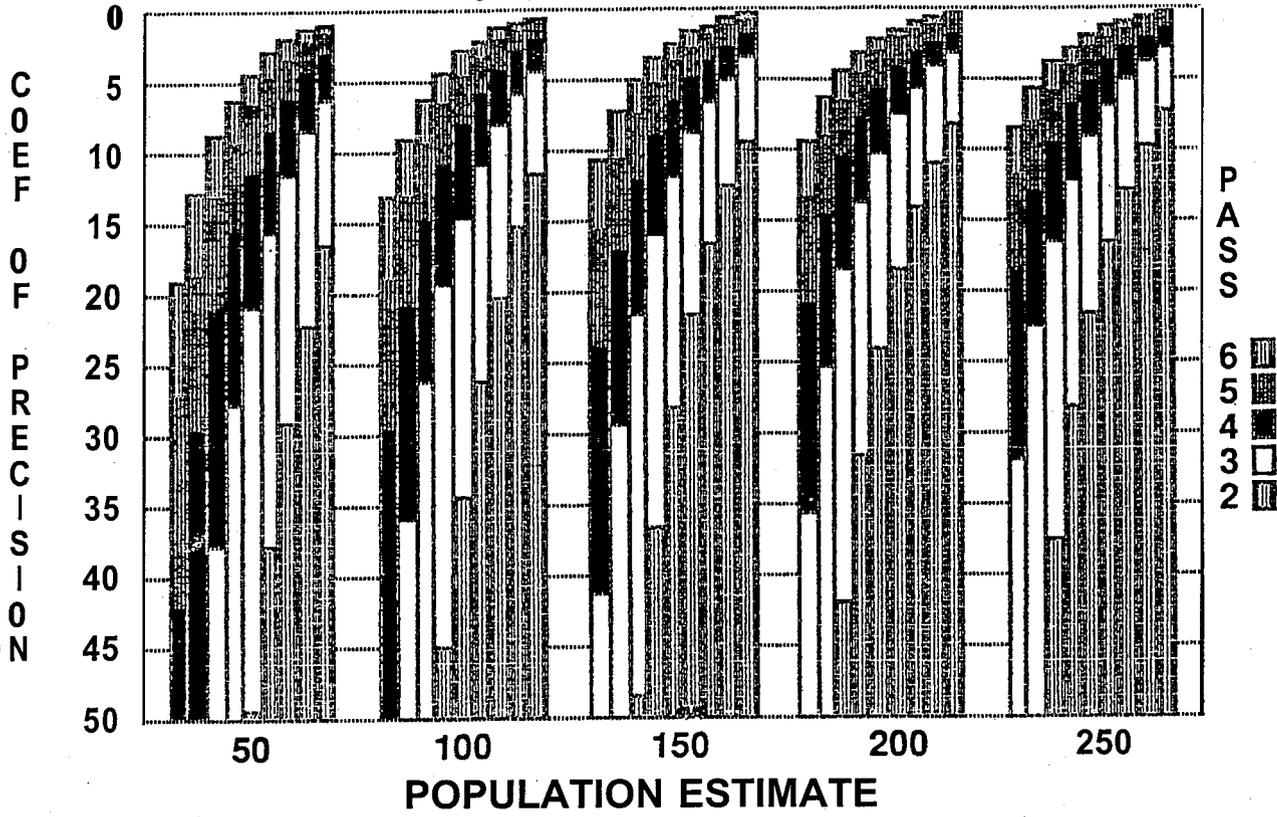
APPENDIX 6: OUTPUT EXAMPLE FROM THE MICROFISH SAMPLE SIZE
PROGRAM (3-D), (MF-SS3D-EXE)
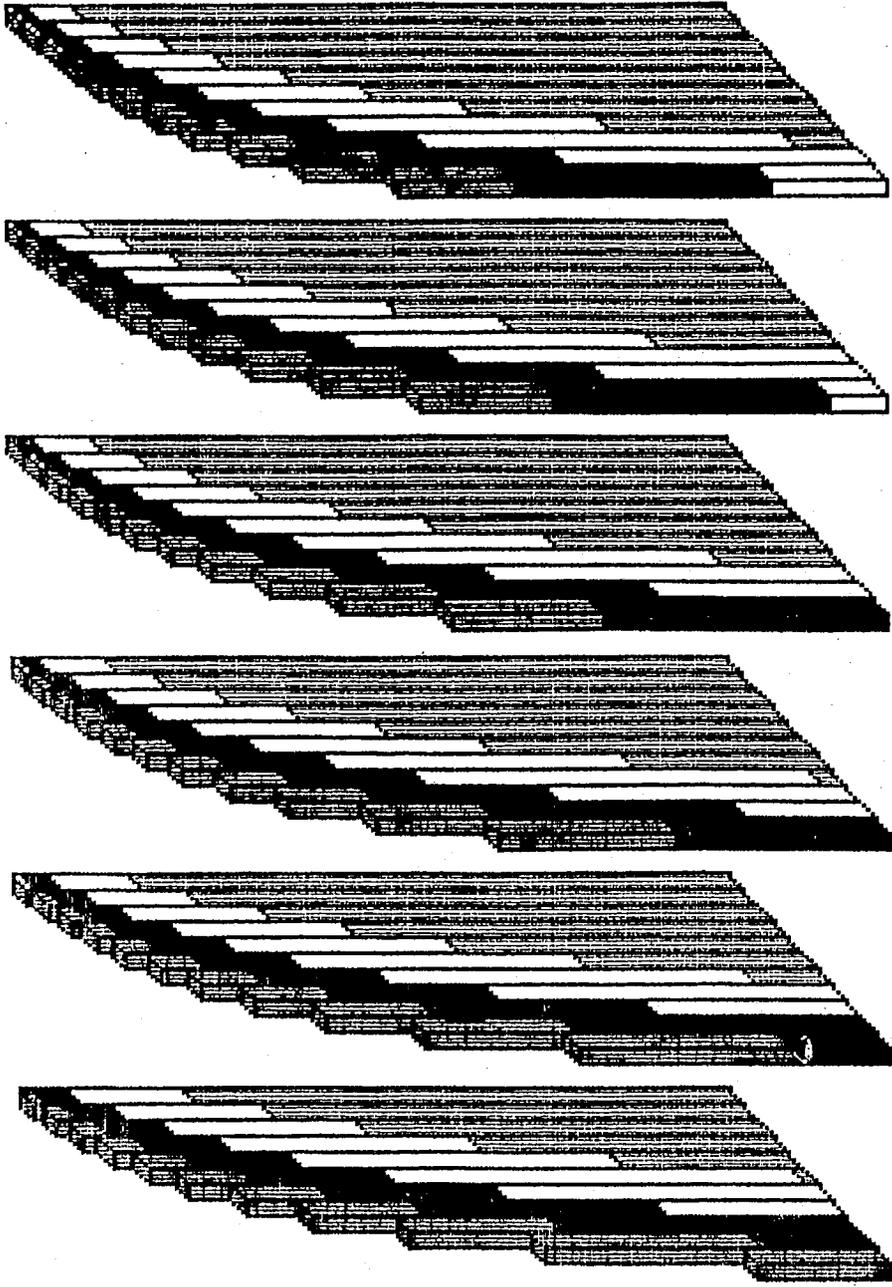
MicroFish (version 3.0) is a microcomputer software system designed for calculating
fisheries population statistics from electrofishing data System output includes *maximum-*
likelihood population estimates, total catches, capture probabilities, removal patterns,
lengths, weights, condition factors, and biomass. Relative percentages, standard errors,
and confidence intervals are generated for each sampling site and species in the data set.
Output options enable the user to create tables or database files which can be used as
input for statistical, spreadsheet, or graphics packages. Sample size programs display
two- and three-dimensional color graphs for predicting the number of electrofishing passes
needed to achieve a desired precision level in the population estimate.

INTERMOUNTAIN RESEARCH STATION

The Intermountain Research Station provides scientific knowledge and technology to improve management, protection, and use of the forests and rangelands of the Intermountain West. Research is designed to meet the needs of National Forest managers, Federal and State agencies, industry, academic institutions, public and private organizations, and individuals. Results of research are made available through publications, symposia, workshops, training sessions, and personal contacts.

The Intermountain Research Station territory includes Montana, Idaho, Utah, Nevada, and western Wyoming. Eighty-five percent of the lands in the Station area, about 231 million acres, are classified as forest or rangeland. They include grasslands, deserts, shrublands, alpine areas, and forests. They provide fiber for forest industries, minerals and fossil fuels for energy and industrial development, water for domestic and industrial consumption, forage for livestock and wildlife, and recreation opportunities for millions of visitors.

Several Station units conduct research in additional western States, or have missions that are national or international in scope.

Station laboratories are located in:

Boise, Idaho

Bozeman, Montana (in cooperation with Montana State University)

Logan, Utah (in cooperation with Utah State University)

Missoula, Montana (in cooperation with the University of Montana)

Moscow, Idaho (in cooperation with the University of Idaho)

Ogden, Utah

Provo, Utah (in cooperation with Brigham Young University)

Reno, Nevada (in cooperation with the University of Nevada)

ATTACHMENT D

Pre-Season Equipment and Safety Checklist

BACKPACK ELECTROFISHING MAINTENANCE/SAFETY CHECKLIST

- ☐ Anode and cathode are clean and securely connected, continuity tested and found to be good

- ☐ fuel is mixed gas 50:1 ratio, batteries are fully charged and connections secure and in good condition

- ☐ Quick release buckles are working properly

- ☐ Tilt shutoff switch is working properly

- ☐ Immersion cutoff switch is working properly

- ☐ Shock unit magnetic switch is functioning properly

- ☐ Battery/generator securing clips/straps in working/good condition

- ☐ Input power switch is functioning properly

- ☐ Overload indicator light is functioning properly

- ☐ Check to ensure the self-test indicator light is functioning properly

- ☐ Output audio voltage indicator is functioning properly